IPA 2021

INTELLECTUAL PROPERTY AWARD CEREMONY
THE AWARD DEDICATED TO THE EXCELLENCE OF ITALIAN PUBLIC RESEARCH

28TH OF FEBRUARY TO THE 1ST OF MARCH 2022
ITALIAN PAVILION / AUDITORIUM

ITALIAN CREATIVITY BRIEF

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IPA 2021

INTELLECTUAL PROPERTY AWARD

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INDEX

A ROAD TO INTELLECTUAL PROPERTY AWARDS

THE AWARD DEDICATED TO THE EXCELLENCE OF ITALIAN PUBLIC RESEARCH

The Covid-19 outbreak is amongst the most dramatic events that will leave an indelible mark on the history of humanity; at the same time, there are many events worldwide, which look towards the future with a positive outlook. Among these, undoubtedly is the speed, intensity and ability of Italian society to adapt and react, leveraging on its own creativity and inventiveness; deeply rooted within the cultural background of a country, that has always been able to look ahead, research and adopt new solutions in the time of need.

To this end, the Ministry of Economic Development and the Section Commissioner General for Italy EXPO2020 Dubai, wanted to fully seize the opportunity to present the phase final of the Intellectual Property Award (IPA) 2021 competition, conceived and created by the Italian Patent and Trademark Office of the Ministry of Economic Development in collaboration with Netval (the Italian Network for the Valorisation of Public Research). An award dedicated to the excellence of Italian public research, characterized by expertise, competence and dynamism; with the key main players being Universities, Public Research Organizations, and Research Hospitals (IRCCS).

IPA 2021 provided an opportunity for institutes belonging to the Italian public research sector, to present their most avant garde solutions to tackle challenges with major impact on the global economy: Agritech and Agrifood, Cybersecurity, Artificial Intelligence, and Big Data, Green Technologies and Alternative Materials, Life Science and Health Care, Aerospace, Renewable Sources, Alternative Energy and Water, and last but not least Future Mobility. A competition that received a great response, with 38 research institutions participating and submitting, 217 patents in the above-mentioned research areas.

EXPO Dubai 2020 right now, is the place where the cultures of the world come together to celebrate achievements and advances in science, technology, design and business. A prestigious and ideal stage for presenting the fruits of Italian creativity, ingenuity and research to the world, consolidating that bridge between research sphere and that of businesses and investors.

We are proud to present the thirty-five (5 per category) IPA 2021 finalists at EXPO Dubai 2020; selected by a scrupulous panel of national experts. The 7 winners whose technology will be deemed the most disruptive from each category will be awarded a cash prize of €10,000. A contribution by the Ministry, to be paid to the University, Public Research Body or Research Hospitals, to be invested in future development of the patent.

This is an important event for our institutions committed to creating more effective processes to cater for the needs of a society in constant evolution. We hope that in these two days, which will involve the participation of local investors and entrepreneurs, thanks to ITA (Italian Trade Agency), will create and pave the path for the enhancement of these innovative technologies. This aligns well with our daily mission, that constantly commits us to share, represent and enhance Italian innovation. We are convinced and aware that the development and economic growth of global companies will be increasingly determined by the ability to apply the sow the seeds of innovation and of ingenuity.

DOTT. ANTONIO LIROSI
Director General of the Directorate General for the Protection of Industrial Property
Italian Patent and Trademark Office, Ministry of Economic Development

ING. GIUSEPPE CONTI
President of Netval - the Italian Network for the Valorisation of Public Research

TECHNOLOGY TRANSFER ECOSYSTEMS IN ITALY

Netval - Network for Research Valorisation

Netval is the Italian association for the valorisation of results from public research. A network of 99 organizations: 64 Universities, 15 Public Research Organizations (PRO), 14 Research Hospitals (IRCCS), 6 foundations (including associations and agencies), whose mission is to bring value, and showcase the world of public research, via the creation of a community of TTO Manager professionals (over 400 in 20 years). Founded as an informal network between universities in 2002, Netval subsequently became an association in 2007, and extended its membership to include non-university members. Associazione Netval is involved in organizing seminars and running workshops in technology and knowledge transfer, to provide support to its network of TTOs and to provide support of upcoming similar networks. Netval's head office team also manages the Knowledge Share IP Platform for the dissemination of research findings.

Find us at: https://netval.it/en/
Contact us at: segreteria@netval.it

Knowledge Share

Knowledge Share is a joint project involving the Politecnico di Torino, the Italian Patent and Trademark Office (UIBM) at MISE (Ministry for Economic Development) and Netval. Managed by Netval, in partnership with the Italian Patent and Trademark Office (UIBM), an office of the Ministry of Economic Development, and the Politecnico di Torino, the platform now boasts over 1,600 patents in various areas of R&D, including but not limited to: Life Sciences and Healthcare, Eco-Architecture and Materials, Renewables and Alternative Energy, Water Management and Technology, Aerospace, Transport, Agriculture, Cybersecurity, Robotics and ICT. Via KS the Italian universities belonging to the Netval network can showcase their research at a global level and establish fruitful conversations, to bring their innovations from bench-scale to the market. Currently, Knowledge Share has facilitated over 150 industry-academia conversations and comprises a network of more than 3,000 industry users comprising investors, companies and SMEs. Knowledge Share works also with similar international networks, in order to share its 'know-how' and provide support to those who wish to create a similar national ecosystem, and is always open to welcome new collaboration opportunities.

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AGRITECH AND AGRIFOOD

DEVICE FOR MEASURING TANNINS IN A LIQUID
TECHNOLOGY READINESS LEVEL (TRL): 4

ALMA MATER STUDIORUM – UNIVERSITÀ DI BOLOGNA

Team Delegate Eleonora Iaccheri
Patent number 102019000002585
License INTERNATIONAL

CHALLENGE
Measuring the tannin content at various stages of grape processing is an important parameter for wine producers. By measuring the content of polyphenols, it is possible to estimate the concentration of tannins. However, this not being a straightforward process it requires sophisticated and expensive techniques, which are often beyond the producers' means. To date various alternative, cheaper and also portable technologies have been developed, however these are still not widely available and still out of reach from the local users. In order to fill this gap, the inventors have created a portable device able to quickly provide a quantitative measurement of tannins, easy to use and at low costs.

TECHNOLOGY
An analytical device for tannins quantification in oenological products and beverages of vegetable origin, that exploits the selective reactivity of tannins in a mixture containing gelatine, the result of which is the formation of turbidity that is measured with high accuracy by using an optical prototype detector, which operates with a pulsed light electromagnetic source, sensitive to the maximum peak wavelength around 890 nm. The readings showed low interferences from the physical and compositional characteristics of the tested samples, making this potentially applicable to a wide range of products, from beverages, juices, extracts and food supplements. The developed method can be assembled into a portable kit comprising an optical meter, reagents, and instructions for the preparation. The current prototype and advanced research state would allow the direct industrialization of the measurement system. The interest of the final user is achieved by the simplicity of use and by the low cost.

DEVELOPMENT STATUS
Current results are based on results obtained via testing on single-variety Italian red wines of various types and geographic origins and variable concentrations of tannins (range 6 - 2700 mg/L). Further development is envisaged to: a) develop a fully validated kit; b) find partners interested in co-development, be they investors and/or industries; c) application for national/international certification of the kit.

COMMERCIAL OPPORTUNITY
Initially designed for supporting the wine industry through the rapid and accurate quantification of the tannin content present in red wines, due to the robustness of the method, it can find application other industrial processed involving of maceration of plant substances, to evaluate their effectiveness under specific process conditions (e.g., tea, coffee, beer, nutraceuticals, cosmetics, animal feed, active packaging). The device can also be adapted to measuring the tannin content of commercial extracts available as food-grade additives, to evaluate their quality and doses of use.

Contact the team via Knowledge Share

FOOD PASTEURIZATION WITH HIGH PRESSURE CO2
TECHNOLOGY READINESS LEVEL (TRL): 5

UNIVERSITÀ DEGLI STUDI DI PADOVA

Team Delegate Sara Spilimbergo
Patent number 102017000098045
License INTERNATIONAL

CHALLENGE
Currently, food preservation methods use high temperatures that modify the nutritional and sensorial characteristics of the product. The increasing demand for fresh and healthy food is driving research towards innovative and mild pasteurization methods. The use of supercritical carbon dioxide (scCO2) represents a promising alternative in terms of i) shelf-life extension ii) sensorial/nutritional quality preservation and iii) food waste reduction.

TECHNOLOGY
This invention uses high pressure CO2 to pasteurize solid food, at temperature (35-45°C) and pressure (75-180 bar) conditions that do not alter its quality in terms of structure, flavour, colour and nutritional value. Indeed, the process allows longer product shelf life since it assures a significant reduction of the natural microbiota on the food product in terms of moulds, yeasts and bacteria; moreover, it is also effective against possible contamination by foodborne pathogenic bacteria. The technology is applied to pre-packed food products, thus avoiding the risk of post-process contamination. CO2 is non-toxic, odourless, and considered GRAS (Generally Recognized As Safe) by the FDA. The technology will find its primary application in the raw/fresh food segments including meat, dairy, fruits and vegetables, but also to snacks and fresh products for canteens or automatic vending machines, as well as ready-to-eat hot or cold meals.

DEVELOPMENT STATUS
The invention is currently being tested on a 90 L semi-industrial plant thanks to the development of a Proof-of-Concept Project funded by Progress Tech Transfer. Different foodstuffs are being tested in order to identify which are the most suitable for the process. The method is also the object of the project HO-FOOD funded by H2020 ERA-NETs SUSFOOD2/CORE Organic. At the moment,
we are finalizing the acquisition of "beta customers" to jointly tune our technology to specific products/packaging of interest. Further development will continue through a University Start-up, launched by 2022.

COMMERCIAL OPPORTUNITY
The potential market is particularly wide as it involves almost the entire high-barrier food packaging industry, which is expected to reach over 40 thousand million US dollars by 2025. The technology here described can be applied at least in these two main segments: 1) Ready-To-Eat and Ready-To-Cook food; 2) Packaged products of animal origin destined for raw or cooked consumption. The first packaging/pasteurization plants can be ready for the market in approximately 18-24 months.

Contact the team via Knowledge Share

METHOD FOR DETECTING *MACROPHOMINA PHASEOLINA*
TECHNOLOGY READINESS LEVEL (TRL): 4/5

UNIVERSITÀ DI PISA

Team Delegate Susanna Pecchia
Patent number 102017000057466
License EUROPE

CHALLENGE
The plant pathogen *Macrophomina phaseolina* is distributed worldwide and has a host range of more than 500 plant species. The fungus attacks crops that are the source of staple foods, and causes yield losses of up to 90% in sunflower, 30-60% in strawberry, 50% in soybean and 70% in corn. Alongside the more traditional diagnostic methods (direct techniques), which require long execution times and highly qualified personnel, indirect diagnostic techniques have been developed, which aim at the identification of pathogens through the analysis of their nucleic acids. The increasing demand for "ready-to-use" diagnostic tools and the great impact of the pathogen on global food production has required the development of faster and more highly specific diagnostic kits.

TECHNOLOGY
Use of species-specific primers pair for the phytopathogenic fungus *Macrophomina phaseolina* to detect its presence in infected soil, seeds and plants samples. The patented primers, labelled at 5' end with biotin and FITC, amplify a target DNA region of the fungus by PCR. These amplified regions, called amplicons, are identified by a NALFIA assay with a simple immunochromatographic stick. In the diagnostic kit all PCR components, the patented primers, and the excipient for cryopreservation, are freeze-dried. This allows to have a diagnostic tool ready to use at room temperature and able to carry out the analysis not only in the laboratory but also directly in the field. The freeze-dried format is simply reconstituted by adding nuclease-free water along with the DNA template saving time and reducing the risk of contaminations. The diagnosis is carried out in about 2 hours and includes in summary: the preparation of the sample, the extraction of nucleic acids, and the PCR-NALFIA assay. This technique has recently been adopted for the early stages of the diagnostic kit development.

DEVELOPMENT STATUS
A first prototype of the molecular diagnostic kit has already been developed and validated using laboratory and field samples. The industrial development of a commercial diagnostic kit, called MP102IDENTI-KIT, is planned in collaboration with a company specialized in the freeze-drying sector with proven experience in the development of products for molecular diagnostics.

COMMERCIAL OPPORTUNITY
The need for rapid and reliable diagnostic methods is an important requirement for the development of environmentally sustainable control strategies.
As there are no commercial kits on the market for the proposed application, MP102IDENTI-KIT could be the ideal solution for a very large global user base: companies that produce diagnostic kits, the phytosanitary diagnostic laboratories, both public and private, and the human clinical pathology laboratories.

Contact the team via Knowledge Share

PEPTIDES FOR PLANT PROTECTION
TECHNOLOGY READINESS LEVEL (TRL): 6

UNIVERSITÀ DEGLI STUDI DI PADOVA

Team Delegate Laura Morbiato
Patent number 102018000006817
License INTERNATIONAL

CHALLENGE
The use of biocompatible fungicides to control plant diseases is encouraged worldwide. To fight important grapevine diseases, such as the downy mildew, there are still no sustainable and effective alternatives to copper compounds, which are candidates for substitutions in the European Union. Fungi belonging to the genus *Trichoderma* are biological control agents used successfully in field trials against many pathogens, but showing unreliable effectiveness, strongly conditioned by environmental factors in the field.

TECHNOLOGY
Fungi of the genus *Trichoderma* produce peptaibols, secondary metabolites that are known for their antimicrobial properties and ability to elicit plant defence mechanisms. Peptaibols are naturally produced as a complex mixture of congeners with unreliable efficacy. This patented product is conversely a pure compound. Compared to other peptaibol based products on the market, which are generally non purified natural extracts, this biocompatible product is much more effective, as well as soluble in water and stable in sunlight. The use of water-soluble analogues makes it possible to avoid the poor reproducibility associated with the use of both peptaibols as they are, and microorganisms of the genus *Trichoderma*. The analogues maintain the beneficial effects on plants, making field distribution easier for the operator. Peptides have been tested in vitro (alone or in combination) against various pathogens of fruit plants, grapevine in particular, vegetables, and cereals, as well as in open field experiments proving effective in inhibiting the development of the disease already at low micromolar concentrations.

DEVELOPMENT STATUS
The research activities aim to develop an ecofriendly and economic peptide synthesis protocol, to minimize production costs of the biocompatible peptide and penetrate the biopesticides market. The inventors, based on feedback received from companies interested in the technology, are still discovering new effective peptides.

COMMERCIAL OPPORTUNITY
The parasites against which the peptides are used are included in the list of the most important and common pathogenic microorganisms of fruit crops, grapevine, horticultural crops, and cereals. Currently, no environmentally friendly alternatives to synthetic fungicides are commercially available against most target pathogens, particularly P. *viticola*. The invention opens up a new opportunity in the market of biocompatible fungicides, that is growing at a CAGR of 14.7%, for companies interested in developing new environmentally friendly and effective products. The chemoenzymatic peptide synthesis strategy is of interest to pharma industries interested in developing new peptide production platforms.

Contact the team via Knowledge Share

RAPID PURIFICATION OF PHYCOBILIPROTEINS
TECHNOLOGY READINESS LEVEL (TRL): 5/6

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Rosaria Lauceri
Patent number 102018000006062
License INTERNATIONAL

CHALLENGE
Phycobiliproteins are water-soluble non-toxic pigment-proteins produced by some microalgae, that have strong antioxidant activity as well as anticancer, anti-inflammatory and immunomodulatory properties, with applications in biomedicine, pharmaceutics, cosmetics and foods. Currently, despite the numerous purification methods available on a laboratory scale, large scale production of phycobiliproteins remains problematic. The complexity of the processes and the high costs involved in obtaining middle-high purity grade phycobiliprotein, constrain its applications and market availability.

TECHNOLOGY
Method to purify phycobiliproteins, extracted from cyanobacteria and algae with aqueous solutions, applying Membrane Chromatography (MC). The MC process is carried out by using microfiltration PVDF membranes, inducing selective and reversible protein-membrane interactions through ammonium sulphate. By changing the ammonium sulphate concentration, it is possible to selectively separate the various phycobiliprotein fractions present in the biomass extract and, applying the appropriate number of MC steps, to achieve the desired purity, up to the analytical grade (P≥4). Analytical grade phycocyanin (extracted from *Arthrospira platensis*, i.e., Spirulina) and B-phycoerythrin (extracted from *Porphyridium cruentum*) have been obtained applying this method.

DEVELOPMENT STATUS
Scale-up of the protected technology in collaboration with the company Plastica Alfa SpA to demonstrate the effectiveness of the technology in an industrial environment. Currently, CNR and Plastica Alfa are partners within a Proof-of-Concept Project, for the realization of an industrial prototype based on this CNR technology to produce high purity phycocyanin for commercial applications.

COMMERCIAL OPPORTUNITY
he technology is based on a simple process and requires low initial investment and service costs, allowing for a very competitive value-for-money ratio. The mild conditions of the process preserve the pigment-protein structure, ensuring high quality product. The method can be tuned in order to obtain products having various grade of purity (maximizing the yield), that meet the needs of various market sectors, from the food/nutraceutical to the biomedical one.

Contact the team via Knowledge Share

CYBERSECURITY, ARTIFICIAL INTELLIGENCE AND BIG DATA

DEVICE FOR THE GENERATION OF SINGLE PHOTON ENTANGLED STATES

TECHNOLOGY READINESS LEVEL (TRL): 3

UNIVERSITÀ DEGLI STUDI DI TRENTO

Team Delegate Nicolò Leone
Patent number 102020000005521
License INTERNATIONAL

CHALLENGE

Secure communication between two people requires sharing a key to encode data that cannot be intercepted or if intercepted cannot be decrypted or the breaking of the secure channel should be known. The generation of random numbers, sources of keys or for computational applications, requires protocols that guarantee the unpredictability of the number sequence. In both cases quantum mechanics, and in particular certification protocols based on the properties of correlation between quantum states (entanglement), allow to ensure both secure keys exchange and randomness of the series of numbers generated. Unfortunately, current entangled photon sources are based on two-photon entanglement (interparticle entanglement); difficult to achieve in low-cost, compact, light, low-power systems. Moreover, two-photon keys sharing requires sophisticated timing systems to measure their coincidences. To overcome these limitations, a single photon entangled source was invented.

TECHNOLOGY

Our invention proposes a practical solution to these problems, presenting itself as a possibility to deploy quantum security certification in consumer applications. In fact, our system starts from any light source (laser, electroluminescent diode, light bulb), uses a simple linear optical system and generates single-photon entangled states (intraparticle entanglement). This allows an easy entanglement certification and keys exchange. The developed entanglement source self-certifies the level of security of cryptographic keys and provides an unbreakable and secure optical link. In addition, being the source small, compact, low power, lightweight, manufacturable in large volumes and at low cost, it is a quantum secure solution in multiple areas ranging from simple embedded solutions in consumer electronics devices to more complex closed systems (e.g. drones, vehicles, buildings, etc.).

DEVELOPMENT STATUS

Currently, a source based on an integrated optical circuit has demonstrated high quality quantum random number generation. Future work will involve the development of a robust packaged system to generate high quality cryptographic keys and the experimental proof of concept of a QKD protocol based on single particle entanglement. The development of the first working prototypes of a compact device connected to a computer will show a bidirectional transmission of a quantum key on an optical fibre in an office-to-office environment as well as in metro applications.

COMMERCIAL OPPORTUNITY

The marketability of the invention is related to the production of quantum security devices, particularly for generating random numbers (QRNG) and distributing a private cryptographic key (QKD). The international market for QRNGs and QKDs is vibrant with early penetrations into the consumer electronics sector (smartphones).
As the awareness of the fragility of current cryptographic systems grows, there will be huge market opportunities that our device can easily tackle.

Contact the team via Knowledge Share

DEVICE FOR PARALLEL PROCESSING OF DATA IN MEMORY
TECHNOLOGY READINESS LEVEL (TRL): 3

POLITECNICO DI TORINO

Team Delegate Fabrizio Riente
Patent number 102019000013542
License INTERNATIONAL

CHALLENGE
Currently, the computing paradigm adopted in the PCs and Smartphones is based on the Von-Neumann architecture, where a processing unit (CPU) and the memory are present, which requires a continuous exchange of data between the processor and the memory in order to perform elaboration, dissipating lot of power. The technology proposed, the racetrack logic, is a non-volatile memory with computing capabilities, able to perform computations directly on the stored data. The proposed device can implement logic functions that cannot be integrated in standard memories. Moreover, the computation is executed in parallel over the whole array in a single clock cycle, without the need of external circuitry.

TECHNOLOGY
Having the possibility to perform the elaboration locally, within the memory, the data transfer between the CPU and the main memory is drastically reduced, especially for data intensive applications. As data transfer is energetically expensive, it must be reduced to increase the battery life of portable devices. The racetrack logic technology can have a strong impact on all portable electronic devices like IoT nodes, tablets, PC or smartphones. Indeed, the aim of device manufacturers is not only to achieve higher performance, but also to increase the battery life of their products. More importantly all data stored inside the memory can be elaborated at the same time, like in content addressable memories. The realization of the racetrack memories is based on a multilayer stack of CoFeB and MgO deposited and structured to obtain the magnetic strips necessary to store data. By means of electrical contacts, suitably defined at the ends of the strips of magnetic material, it is possible to move and process data by exploiting a current that passes through the material.

DEVELOPMENT STATUS
The € 50k loan, granted by the Compagnia di San Paolo and Liftt in 2021, made it possible to accelerate the development of the prototype by validating the individual elements of the manufacturing process. To date, the 3D manufacturing process has been validated. The team is creating a device with multiple memory cells adopting MTJs for writing and TMRs for reading data.

COMMERCIAL OPPORTUNITY
The serviceable addressable market is the one related to non-volatile memories and in particular the one integrated in microcontrollers (MCU), System on Chip (SoC) and ASIC. This market holds about 100% of the currently non-volatile memories. Inventors are looking for potential investors in the semiconductor industry interested in obtaining the patent under license.

Contact the team via Knowledge Share

IPOGNAC: A HIGH-PERFORMANCE QUBIT SOURCE FOR QUANTUM KEY DISTRIBUTION
TECHNOLOGY READINESS LEVEL (TRL): 8

UNIVERSITÀ DEGLI STUDI DI PADOVA

Team Delegate Giuseppe Vallone
Patent number IT102019000019373; PCT/EP2020/079471
License INTERNATIONAL

CHALLENGE
Quantum Key Distribution (QKD) is an emerging quantum technology that, by exploiting the quantum mechanical nature of light, allows two distant parties to obtain a secret key with unconditional security. QKD has gained widespread adoption and strategic importance as several standard encryption schemes have proved to be insecure, especially with the rapid development of different quantum computing platforms. In fact, keys generated with QKD provide perfect security against any possible attack, quantum computers included, and can be used for symmetric key cryptography when high levels of privacy and long-term secrecy are required. A main challenge for the development of QKD systems is the generation of qubits with long-term temporal stability and low error rates.

TECHNOLOGY
The iPOGNAC is a high-performace qubit source for QKD based on the polarization modulation of photonic pulses. Polarization modulation is performed exploiting a patented self-compensating scheme that offers high-quality generation of perfectly known polarization states that do not vary over time. Compared to other polarization modulation methods, the iPOGNAC is resistant to quantum hacking attacks, does not need to be recalibrated over time and is robust to temperature and mechanical fluctuations. This makes the iPOGNAC a valuable and unique source for the development of QKD systems that can be deployed in fibre-optical or free-space channels, such as satellite communications.

DEVELOPMENT STATUS
The iPOGNAC has been used to develop several QKD system prototypes, for both scientific and commercial purposes, which have been tested in different operative contexts. In particular, the iPOGNAC has been tested in free-space and fiber-optical channels, including different field-trials over the communication infrastructure of the University of Padua. Furthermore, the iPOGNAC has been developed and tested at different wavelengths including the telecom C and O bands, as well as the NIR band exploited in free-space links. Lastly, the iPOGNAC is being tested to obtain space qualification.

COMMERCIAL OPPORTUNITY
The inventors, together with Officina Stellare SRL (manufactures of high-tech opto-mechanical system instrumentation for Ground and Space-based applications) and other researchers from University of Padova, have launched ThinkQuantum, a University Spin-off that is commercializing the patented technology and all related know-how. The numerous contacts and the different activities of inventors both nationally and internationally, combined with the economic support and scientific skills of the industrial investor, have created a promising development path to ensure the success of the technology in the reference market. The quantum communications market is expected to reach 4 billion by 2030, according to a report by Inside Quantum Technology. The current goal is to employ the iPOGNAC-based QKD systems in public networks to ensure the protection of sensitive material in the academic, government, military or commercial sphere.

Contact the team via Knowledge Share

METHOD FOR SENDING CLASSICAL DATA IN QUANTUM INFORMATION
TECHNOLOGY READINESS LEVEL (TRL): 4

ALMA MATER STUDIORUM – UNIVERSITÀ DI BOLOGNA

Team Delegate Marco Chiani
Patent number 102019000010797
License INTERNATIONAL

CHALLENGE
Quantum information processing by systems including quantum computers and quantum networks have been known since some years. Despite the potential advantages in exploiting the quantum mechanics to process information, there are still several problems to solve.
One aspect is that the management of these networks will inevitably require to exchange control data in addition to the user data in order to obtain secure exchange of data. The proposed invention tries to solve this problem and allows, for any quantum communication system employing quantum error correcting codes (QECCs), to read and write classical information on top of quantum information. The method thus defines a communication protocol to send a sequence of classical bits superimposed to qubits protected by QECCs by the introduction of intentional errors on the qubits, making the transmission of information secure.

TECHNOLOGY
A quantum piggybacking to write and read classical information on quantum information using the error syndromes of a Quantum Error Correcting Codes (QECC), without destroying the quantum superposition. Consider a quantum link employing a quantum error correcting code, where k data qubits are encoded into a codeword of n>k qubits. The quantum error correcting codes is designed to detect errors introduced in the link, by reading what is known as quantum error syndrome. Reading the error syndrome does not change the quantum information (superposition), but allows the decoder to correct, hopefully in most of the cases, the error. Due to quantum mechanics, the possible errors can be assumed to be in a finite set. The basic idea of piggybacking is to send classical information by introducing in transmission intentional errors, chosen from the set of correctable errors. The decoder at the receiver side can then measure the quantum error syndromes and infers the intentional error, which constitutes the classical piggybacked information. The aforementioned procedure creates a discrete-input discrete-output classical channel, referred to as a piggyback syndrome channel, which stays on top but does not disturb the quantum information.

DEVELOPMENT STATUS
The technology has been demonstrated on cloud quantum computers. Collaboration is sought with key players in the quantum Internet industry, and with international research projects pursuing quantum information technologies.

COMMERCIAL OPPORTUNITY
Ability to build a packet-based quantum network,
for applications in communication, computing, sensing and metrology. Provide quantum frame synchronization: a unique word of intentional errors can be used to identify the beginning of a frame and can be read without modifying the quantum superposition.

Contact the team via Knowledge Share

TOOTHPIC: SECURE PASSWORD-LESS AUTHENTICATION
TECHNOLOGY READINESS LEVEL (TRL): 8

POLITECNICO DI TORINO

Team Delegate Giulio Coluccia
Patent number 102016000105253
License INTERNATIONAL

CHALLENGE
Current authentication systems suffer from a trade-off between security, usability and cost. It is well known that passwords, text messages, and tokens are no longer sufficient to guarantee security and a frictionless user experience in today's digital world. In this scenario, ToothPic technology has been developed and patented as a solution to solve this problem and allows corporations' customers and employees to turn their smartphone in a secure key to access online assets, leveraging the unclonable features of the camera sensors.
As the technology is implemented as an SDK, corporations can minimise the costs related to implementation and support.

TECHNOLOGY
Starting from research activities carried out at Politecnico di Torino, ToothPic invented, developed and patented a technology turning every smartphone into a secure authentication key. The unique technology provided by ToothPic securely stores cryptographic keys on smartphones by encrypting them with a secret extracted from a hardware characteristic of the device itself: the unique and unclonable pattern of manufacturing imperfections of camera sensors.
A feature that makes every single produced device different from each other. With this technology, the secret key is never exposed, neither in the long-term nor in the short-term device memory. In this way it is protected from malware: even if the entire content of a device were cloned, the cloned credential would be unusable as the destination device has a camera different from the one of the original device used to generate that credential. Moreover, ToothPic is the only technology able to identify a device even after a device factory reset,
or after an application reset.

DEVELOPMENT STATUS
The Proof-of-Concept phase, started in 2020 and ongoing, consisted in opening the product for external integration and testing, and the operations to secure the implementation (like static code review, architecture analysis, penetration testing). The technology has been deployed on two customers, hence reaching TRL 8. A preliminary investigation and research phase on the applicability of the technology to laptops is currently ongoing.

COMMERCIAL OPPORTUNITY
The patent is licensed exclusively to ToothPic, a start-up founded by the inventors for the commercialization of products based on the IP. The technology has been implemented as an SDK for Android and iOS to be integrated into third-party systems. The SDK received the FIDO2 certification in 2020 by the FIDO Alliance, a consortium of big players like Google, Apple, Facebook, Amazon, Paypal, RSA, IDEMIA, VISA, Mastercard, Samsung. The start-up secured 2 funding rounds of €300K in 2018 by the VV3TT fund and €810k in 2020 by VV3TT and Club degli Investitori di Torino. The go-to-market activity led to PoC projects with Italian System Integrators, Identity Providers and major financial institutions. The company objective is to realise revenues for €300k Euro in 2022 and up to €2M in 2024.

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GREEN TECHNOLOGIES AND ALTERNATIVE MATERIALS

ADDITIVE MANUFACTURING PROCESS FOR NON-OXIDE CERAMICS

TECHNOLOGY READINESS LEVEL (TRL): 4

POLITECNICO DI TORINO

Team Delegate Abdollah Saboori
Patent number 102018000006916
License INTERNATIONAL

CHALLENGE

Additive Manufacturing solutions are commonly used with polymers and metals, and are not suitable for advanced ceramic materials because of their high melting temperatures, stiffness and their brittle behaviour. For this reason, the patented process exploits mixed powders made of metallic and non-metallic particles with a specific composition defined for reacting during the interaction with the energy source thus generating, directly in the AM machine, the final non-oxide ceramic material. In this way the creation of the of the final non-oxide ceramic material, the shaping of the complex shaped component and the consolidation of the solid volume take place in a single step without requiring very high temperatures.

TECHNOLOGY

Exploiting vacuum additive manufacturing technologies through a single-step process this technology enable the synthesis, the controlled densification and the shaping of non-oxide materials, in porous as well as fully dense ceramic components, with a tailored nano-micro-macrostructure. The application of solid-state sintering for non-oxide ceramics has always been complicated because their strong and predominantly covalent atomic bonds inhibit solid-state diffusion below their decomposition temperature, thus requiring extremely high process temperature. A second aspect, that makes solid-state sintering a difficult process, is related to the necessity for non-oxides to conduce the process in reducing or inert atmosphere to prevent their oxidation. Moreover, with actual technologies is not possible to produce complex geometries, requiring further machining work to obtain the final object. This invention allows to perform in situ synthesis, densification at a controlled rate, and shaping of non-oxide ceramic parts by using a vacuum additive manufacturing technology, in which thermal energy is supplied by a laser or electron beam and focused on a powder bed, progressively deposited following 3D model data to shape the desired component.

DEVELOPMENT STATUS

Prototype testing undertaken, to demonstrate feasibility and evaluate the changes in properties of the non-oxide ceramics processed through the patented process. Considering alternative applications where the technology can be useful for the use of non-oxide ceramics.

COMMERCIAL OPPORTUNITY

In the automotive/aerospace sector ceramics can be use to increase the possible engine temperature thus increasing its efficiency and reducing fuel consumption and emissions. Through this process ceramics can also be exploited through the employment of parts in a variety of sensors, mechanical seals, ceramic bearings, valves and fabrication of bespoke components.

Contact the team via Knowledge Share

METHOD FOR THE RECOVERY OF PALLADIUM
TECHNOLOGY READINESS LEVEL (TRL): 4

UNIVERSITÀ DEGLI STUDI DI CAGLIARI

Team Delegate Angela Serpe
Patent number 102018000009093
License ITALY

CHALLENGE
Palladium (Pd) is a rare and precious metal that finds application in a large number of fields, including the production of catalysts, electronics, jewellery, chemistry, and medicine. Among the various uses, the most important in terms of quantity is the manufacture of catalysts used in the automotive sector for the conversion of exhaust gases. Given its rarity and its high value, it is vital to have efficient recovery methods of Pd from scraps and waste or contaminated waters. Current solutions that aim to recover palladium may have some technological, functional, and environmental limitations such as the low selectivity and efficiency as well as the large amount of volatile organic compounds (VOCs) or solid extractants typically employed.

TECHNOLOGY
Exploiting Cloud Point Extraction in the presence of a "green" ligand dissolved in a small amount of non-ionic surfactant, Pd is efficiently and selectively extracted from industrial wastewaters or leachates deriving from the non-selective chemical treatment of solid materials containing metals (mineral or secondary raw materials e.g., car catalysts and Hi-Tech waste). As an alternative to the solvent extraction methods, which use large amounts of VOCs and require numerous steps, in this invention Pd can be selectively and quantitatively extracted in few minutes putting in contact the multi-metal solution with a small amount of a low cost and environmentally friendly non-ionic surfactant containing the selected ligand, then raising the temperature to exceed the cloud point. The Pd complex obtained from the interaction with the ligand is concentrated in the surfactant phase and easily recovered from it.

DEVELOPMENT STATUS
The method, based on one or two short liquid-liquid extraction stages at room temperature and a recovery phase from the extraction phase, promises to give rise to a simple and economically and environmentally sustainable industrial process. The suggested class of ligands can be obtained through a simple and low-cost synthesis route. A sophisticated laboratory-tested method, which can be scaled and applied in different contexts where water purification is required with the simultaneous recovery of precious metal values. Patent application pending in USA and EU (PCTIB2019058368).

COMMERCIAL OPPORTUNITY
Designed for the recovery and recycling of Pd from Hi-Tech waste, reclamation, and enhancement of wastewater (from chemical laboratories, industrial processes, mining processes, etc.) where multi-metallic aqueous solutions containing also low concentrations of the metal are produced. It can be easily scaled-up for industrial applications and find open doors to new markets for the purification of wastewaters whilst simultaneously recovering precious metal fractions.

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RE-PAPER: REUSABLE SILICA MONOLITHS FOR DECONTAMINATING RECYCLED PAPER PULP
TECHNOLOGY READINESS LEVEL (TRL): 6

ALMA MATER STUDIORUM / UNIVERSITÀ DI BOLOGNA

Team Delegate Enrico Buscaroli
Patent number 102016000072535
License INTERNATIONAL

CHALLENGE
Use of recycled fibres to produce food packaging is problematic. Cellulosic packaging can contain dangerous substances: mineral oils, benzophenones, diisopropyl naphthalenes and phthalates. Particularly, the concentration of these contaminants tends to increase in recycled packaging due to previous printing processes and water recirculation in paper mills. These toxic compounds, if not treated accordingly, can migrate from paperboards into food products. Most of these hydrocarbons can be assimilated into the human body through ingestion of contaminated food. Some of them have carcinogenic effects or interfere with the endocrine system. Current recycling technologies fail to produce clean and safe recyclable food packaging materials. The alternatives are high in costs or have low-eco-sustainability.

TECHNOLOGY
Incorporated in the production of recycled paper/paperboard allows to remove mineral oil, whose aromatic fraction is claimed to be carcinogenic. In the field of cellulosic-based food packaging, the currently available technologies are aimed at reducing the migration of contaminants to food, rather than decontaminating cellulose. Preventing migration of hazardous hydrocarbons from packaging to food requires the addition of plastic layers, aluminium, or the use of virgin cellulose fibres. These solutions have significant economic and environmental costs. Re-paper technology, on contrary, decontaminates recycled fibres during recycling process, allowing the production of clean, safe recycled cellulose at low costs and low impacts. The technology exploits: 1) the addition of special non-toxic food-grade surfactants to the wet recycled pulp, facilitating the removal of hydrocarbons contaminants from cellulose fibres, and 2) the capture of solubilised contaminants removed from paper. Since water is constantly recirculated in recycled paper mills, spent water is cleaned-up with synthetic silica sorbents (in form of solid monoliths) specifically designed to adsorb highly non-polar substances (such as hydrocarbon contaminants) and capable to be regenerated and reused several times. Adopting this technology does not require substantial capital expenditures by paper mills as it does not modify the production line. Furthermore, paper mechanical and chemical characteristics are not altered by this technology.

DEVELOPMENT STATUS
Proof of Concept Phase started in 2020 with €110k, which were invested to start the industrial development of the patent (Re-Paper Project). Current collaboration with LUCENSE research centre for further process validation, carrying out market research and conducting an LCA on the technology. An MVP is going to be ready by the end of 2022, and market launch is expected in 2023.

COMMERCIAL OPPORTUNITY
To paper and food packaging producers which value sustainability and food safety, Re-Paper is the innovative technology for an effective, efficient, cost-saving decontamination of recycled cellulose pulp. Value is created for the client (paper and pulp industry) by allowing the production of food-safe recycled cellulose at lower costs, avoiding the use of virgin paper, plastic layers, or high energy costing processes necessary to achieve the same purpose. The patented technology can be either 1) sold to a chemicals/special materials supplier of paper and pulp industry, or 2) exploited by a spin-off or star-tup offering a tailor-made service to paper mills, and possibly creating a brand recognizable also to public consumers, to exploit the green reputation due to our eco-friendly technology.

Contact the team via Knowledge Share

REVERSIBLE ADHESIVE SYSTEM FOR BONDING AND DISASSEMBLING OPERATIONS
TECHNOLOGY READINESS LEVEL (TRL): 4

POLITECNICO DI TORINO

Team Delegate Alessandro Benelli
Patent number 102018000006015
License INTERNATIONAL

CHALLENGE
The use of adhesives is growing in many industrial sectors, due to the versatility of their applications and the widespread use of composite materials in all the industrial sectors. When composite materials are used, adhesive bonding is the only way to efficiently join these materials. However, the inability to easily separate bonded components can limit their use. The neat separation of components is important for repairs, replacements, recycling and re-use in the cases of waste during assembly procedures and at the end-of-life cycle. Current technologies do not allow for components to readily separate without sustaining any damage, causing drawback and costly replacements to be sought. A damage-free component separation method is now available, applicable also when the bound components are made of different materials and sensitive to temperature.

TECHNOLOGY
The magnetic gearbox consists of a certain number of The invention allows to simplify the bonding and separation of components made of different parts connected by thermoplastic adhesives. The assembly and disassembling procedures are possible by introducing iron oxide nanoparticles or microparticles within the adhesives that allow the localized fusion of the adhesives by using a magnetic field generated by an innovative inductor. The technology potentially works for all thermoplastic adhesives and for all materials, including plastics and most composites, which are in fact transparent to electromagnetic fields. In the case of components sensitive to electromagnetic fields, i.e. carbon fibre plastics and metals, their conductivity can be used to contribute to the heating of the adhesive itself for bonding operations. The technology works reversibly and therefore can also be used for separation.

DEVELOPMENT STATUS
The technology has been validated on components used in the automotive sector through a Proof of Concept funding. In particular, the interest is aimed at the possibility of separating the components at the End of Life of Vehicles (Directive 200/53 / EC) and for bonding operation assembly. The technology has shown that the system can separate, bond and re-bond after separation plastic components used by the automotive industries. A collaboration with an automotive manufacturer showed that it is possible to bond and disassemble within the time cycle of a vehicle and there are enormous possibilities to reduce costs (up to 50%) during the assembly part. The project shows also that the modified adhesive is industrially scalable.

COMMERCIAL OPPORTUNITY
Reversible adhesives for the industries represent an innovative technology to solve the problem of recycling and reusing vehicle end-of-life components according to the European directives and from a Circular Economy perspective. This technology opens up new scenarios for the separation of adhesives to repair components, to avoid waste and to safeguard the use of raw materials.

Contact the team via Knowledge Share

ZENIT SMART POLYCRYSTALS: MATERIALS FOR INNOVATIVE LASERS
TECHNOLOGY READINESS LEVEL (TRL): 4

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Jan Hostaša
Patent number 102020000005998
License INTERNATIONAL

CHALLENGE
Polycrystalline transparent materials where the dopant concentration is graduated and controlled for light guiding or thermal management, are very promising materials for many laser applications. The performance of the currently used uniformly doped single crystals is limited by the thermal load generated in the active medium during laser emission. To overcome these limits, diffusion bonding is used to join together carefully cut and polished materials, mostly single crystals, with a different dopant or doping level. As an alternative, transparent ceramics with compositional gradients may be produced by assembling multiple layers or parts during shaping. Unfortunately, these fabrication techniques do not allow a precise control of the doping structure of the components. For these reasons, the commercial exploitation of laser gain media is slowed by the lack of an industrial-friendly fabrication process.

TECHNOLOGY
A process to obtain transparent polycrystalline components with complex shapes and compositions that overcome the limits of the components currently used as laser gain media, scintillators and in lighting. It relates to an additive manufacturing process, viz. stereolithography, for the production, starting from a CAD drawing, of ceramic-based transparent materials with a variable 3-dimensional (3D) composition and complex shapes, providing complete control of the shape and of the composition. The invention also relates to all the processing steps that are necessary to obtain the final components, i.e., selection of the starting powders and organic additives mutually compatible and suitable for stereolithography, the de-binding and the sintering treatments The minimum dimensions of the components obtainable with the invention are 0.5 x 0.5 x 0.5 mm, and the maximum dimensions are 100 x 100 x 9 mm.

DEVELOPMENT STATUS
In September 2021, the research team founded a spin-off company, Zenit Smart Polycrystals. Recently, Zenit received an investment for a Proof-of-Concept phase, focused on R&D activities and production of laser gain media prototypes for the solid-state laser market and on the identification of potential. The research team is interested in finding suitable partners for developing lasers used in the medical (surgery lasers) and industrial sector (laser welding and machining), and components for lighting (converters for laser headlights for the automotive sector) and for scintillating detectors.

COMMERCIAL OPPORTUNITY
Solid-state laser market, where the high manufacturing costs, the performance losses due to thermal gradients and parasitic emissions, and the excessive weight and volume of the equipment are a hindrance to development. With this invention, new laser gain media can be produced to replace conventional single crystals, allowing a drastic reduction of the performance losses, thus increasing the laser efficiency. The specific products will be for example YAG polycrystals formed by different chemical compositions both to be used in current devices via a seamless substitution as well as for innovative custom-made solutions.

Contact the team via Knowledge Share

LIFE SCIENCE AND HEALTH CARE

CHIMERIC COMPLEX AND ITS THERAPEUTIC APPLICATIONS IN CANCER AND METASTASIS TREATMENT

TECHNOLOGY READINESS LEVEL (TRL): 4

UNIVERSITÀ DEGLI STUDI DI TORINO

Team Delegate Daniela Taverna
Patent number 102019000015806
License INTERNATIONAL

CHALLENGE

Cancer usually leads to patient death because cells can detach from primary tumors and form metastases in distant organs, which are responsible for about 90% of deaths. In 2018, 18.1 million cancer cases were diagnosed around the world and 9.5 million people died because of cancer. It has also been anticipated that by 2040, the number of new cases will rise to 29.5 million with the consequent death of 16.4 million patients. Therefore, it is important to develop new therapies in order to block or control tumour progression. Chemotherapy and radiotherapy are not always sufficient to block tumour spread and they also result very toxic for the patients. So, it is necessary to develop targeted therapy to specifically hit cancer cells, thus reducing the side-effects.

TECHNOLOGY

The molecule object of the present invention is a chimeric complex, in other words a macromolecular complex which comprises molecules of different nature and characterized by different actions. In particular, this chimeric complex is composed of an aptamer which targets a specific tyrosine kinase receptor (AXL) and a microRNA, called miR-148b, characterized by an anti-metastatic activity. The aptamer is able to bind specifically to the AXL receptor, known to be expressed on the surface of many cancer cells. By doing so, miR-148b is specifically conveyed to cancer cells, where it exerts its anti-metastatic activity. The chimeric complex, indicated as axl-148b, does not target non-tumour cells, that do not express the AXL receptor. Therefore, this chimeric complex is proposed as a therapeutic treatment for malignant solid tumours with are able to form metastases. We already know that axl-148b functions well in vitro and in vivo on breast cancer and melanoma cells and in vitro on lung cancer cells, a big killer among all the malignancies. Since both axl and miR-148b levels are also altered in other kinds of tumour, axl-148b chimeric aptamer may be used to inhibit metastasization also in other neoplasia. Furthermore, axl-148b may be combined with other therapies such as monoclonal antibodies, immunotherapy, hormonal therapy and chemotherapy.

DEVELOPMENT STATUS

Stabilized compound is available, and valued as a competitive market alternative for cancer therapy. Currently, we are characterizing the molecule to conclude pre-clinical studies and developing another structure of axl-148b with the goal of obtaining a highly stable molecule that will allow us to administer axl-148b to patients with a reduced number of administrations. Pre-clinical studies will be conducted in order to assess the toxicity, pharmacokinetics, pharmacodynamics and biodistribution of axl-148b in mice and other animal models.

COMMERCIAL OPPORTUNITY

Seeking pharmaceutical companies working to collaborate and push development to clinical trials.

Contact the team via Knowledge Share

EARLY DETECTION OF HEAD AND NECK SQUAMOUS CELL CARCINOMA
TECHNOLOGY READINESS LEVEL (TRL): 8

ALMA MATER STUDIORUM – UNIVERSITÀ DI BOLOGNA

Team Delegate Luca Morandi
Patent number 102016000111174
License INTERNATIONAL

CHALLENGE
Oral Squamous Cell Carcinoma (OSCC) is the most frequent neoplastic disease of the oral cavity with 600,000 new cases worldwide. Currently, no commercially available methods exist that allow for screening, early detection, or monitoring of OSCC in high-risk groups. In the past few decades, various non-invasive diagnostic tools have been proposed, however, these methods have several limitations including low sensitivity and specificity, and there is no evidence indicating that their use could reduce cancer mortality. Collection of samples from oral brushing, for analysis of OSCC biomarkers has been proposed as an alternative, non-invasive, or minimally invasive screening strategy. We have recently developed an oral-brushing-based minimally invasive method to detect oral carcinomas at an early stage by measuring the DNA methylation levels of a panel of 13 genes.

TECHNOLOGY
The magnetic gearbox consists of a certain number of An in vitro non-invasive method for early detection of OSCC starting from a sample taken with a small brush in oral mucosa is now available. It is based on the quantitative DNA methylation evaluation of 13 genes followed by the calculation of a score able to stratify with high accuracy OSCC vs normal cases. The test was clinically validated in an Italian multicentre trial, reaching a sensitivity of 93.6% and a specificity of 84.9%.
Our 13-gene DNA methylation analysis has also demonstrated its prognostic potential in the follow-up of patients surgically treated for OSCC. Samples taken from the regenerative area after OSCC resection every three months could identify patients at risk of recurrence during follow-up. The method allows to predict any relapses and a bad prognosis.

DEVELOPMENT STATUS
Looking at the generation of a centralized lab service based on Next Generation Sequencing, in which the score will be calculated investigating the DNA from patients coming from dentists and maxillo-facial surgeons. Currently, 1130 samples comprising more than 200 OSCC, more than 200 normal donors, high- and low-grade dysplasia, lichen, parodontitis, and normal contralateral mucosa in all the patients with OSCC have been analysed.

COMMERCIAL OPPORTUNITY
Creation of a spin-off, workshops and learning activities, together with Italian associations of dentistry and oral pathology (ANDI, SIPMO), and with the European Association of Oral Medicine (EAOM). Seeking for partnership with companies in the field of dentistry and maxillo-facial surgery to establish a screening program aimed to reduce the mortality of this disease which is currently 50% within 5 years.

Contact the team via Knowledge Share

I3D: INTRAOCULAR DRUG-DELIVERY DEVICE
TECHNOLOGY READINESS LEVEL (TRL): 4/5

POLITECNICO DI MILANO

Team Delegate Marco Ferroni
Patent number 102017000101582
License INTERNATIONAL

CHALLENGE
Age-related macular degeneration is the main cause of blindness in over 50s: in 2020 only, an estimated 200 million people were affected by this disease. Treatment involved frequent intravitreal injections of specific drugs (vascular endothelial growth factor antibodies). Despite the efficacy of the drug, patient adherence is very low due to fear, complications or hospitalization for other ailments, with the main consequence of irreversible blindness. Thus, there is a problem in the administration of the drug and not in the efficacy of the drug itself. This scenario highlights the need to develop a new technology, a system with the following technological requirements: injectable, biocompatible, biodegradable, scheduled drug release and highly scalable on different applications.

TECHNOLOGY
i3D is an intraocular drug-delivery device able to replicate the current clinical practice without surgery, creating compliance for patients and decreasing healthcare costs. It is able to drastically reduce the number of intravitreal injections and all the burdens associated to the clinical practice, releasing preloaded doses of drug at pre-set times. i3D consists of concentric shells made of a biodegradable material, based on magnesium. The shells are separated by empty spaces each filled with a specific dose of therapeutic agent. Once injected into the vitreous chamber through a standard clinical needle, the system is able to release drug doses at pre-set times, replicating the current therapy. Once the outer shell has been completely eroded, the first dose of the drug is released. In this way, the disease is adequately treated without the burdens associated with the standard multiple injections. After the erosion of the second shell, a further dose of the drug is released similarly. This mechanism is repeated until the complete dissolution of the device, in accordance with the therapy prescribed. The main features and advantages of the proposed technology are related to its biodegradability, biocompatibility and autonomous functioning with pre-set drug release. In fact, magnesium has the unique feature to be degraded by biological fluids, with corrosion products accepted by human body.

DEVELOPMENT STATUS
MgShell Srl, spin-off from Politecnico di Milano, is developing and testing the patented device to complete the in-vitro validation phase and the optimization of the prototyping process. Biocompatibility and cytotoxicity analysis for using magnesium-based device in ophthalmology have been performed in partnership with CNR 's Institute of Translational Pharmacology. Animal experimentation on pig models is going to be performed.

COMMERCIAL OPPORTUNITY
Of interest to pharmaceutical and drug development companies: the patent can derive a very wide range of products and solutions, since the device is completely drug-independent and highly modular in function of the type of the drug that is loaded. It is capable of delivering any kind of active principles for intraocular and extraocular applications, when a by-dose drug release is preferred than a continuous one.

Contact the team via Knowledge Share

PISA: POST-TRANSLATIONAL INTRACELLULAR SILENCING ANTIBODIES
TECHNOLOGY READINESS LEVEL (TRL): 4

SCUOLA NORMALE SUPERIORE

Team Delegate Gabriele Ugolini
Patent number IT102015000068085
License INTERNATIONAL (EU/USA)

CHALLENGE
Diseases originating from individual post-translational modifications (PTMs) of proteins represent a broad therapeutic market, which is not accessible for currently available drugs. The very same protein can display different functions due to different PTMs. Some PTMs are responsible for pathological functions. We aim at treating a disease specifically caused by a single PTM by selectively targeting the PTM variant of the corresponding protein. This cannot be done using currently available technologies, with the consequence that no drug approved so far is directed against a specific PTM of the corresponding target protein. The PISA technology is specifically designed to solve this problem.

TECHNOLOGY
PISA allows you to select antibody domains able to recognize specific PTM protein targets. In addition, the antibodies selected from the SPLINT libraries are already 'guaranteed in their functionality' in the intracellular environment. The selection occurs in yeast cells which can survive in a selective media only upon interaction of the PTM protein target in its native conformation and the specific antibody domain able to recognize it. The nanobody selected can be recovered from the yeast cells as DNA. This allows us to express the antibody domain of interest directly in eukaryotic cells to silence the specific PTM or to produce it as a protein to be used for research, therapeutic or diagnostic applications. This method overcomes the shortfall of current technologies to produce anti-PTM antibodies which rely on the use of PTM peptides instead of the whole native protein. Those antibodies very often do not work intracellularly because they do not recognize the PTM in the context of the native protein.

DEVELOPMENT STATUS
The PISA technology was tested in the laboratory; the proof-of-concept allowed us to isolate two intrabodies binding the acetylated form of HIV1-Integrase and histone-H3. This will be followed by the identification and validation of new generations of targets for diagnostic and pharmacological purposes, their association with specific diseases, and the development of new generation biotherapeutics. The R&D of specific pharmacological molecules will lead to the generation of further patentable results.

COMMERCIAL OPPORTUNITY
The development of new generation biotherapeutics in the clinical areas of Neurodegeneration and Oncology is the objective of our entrepreneurial project (P.I.S.A. Biotech). However, the innovation potential of our technology platform goes well beyond the therapeutic focus of our project: the method for antibody selection can virtually be extended to any type of PTM protein and exploited for target validation as well as diagnostic purposes. The strategy of P.I.S.A. Biotech is to leverage its antibody platform to develop a pipeline of anti-PTM therapeutic antibodies.

Contact the team via Knowledge Share

TARGETING SMALL RNAS AS A THERAPY FOR ALS
TECHNOLOGY READINESS LEVEL (TRL): 4

UNIVERSITÀ DI MILANO BICOCCA

Team Delegate Monica Nizzardo
Patent number 102019000004571
License INTERNATIONAL

CHALLENGE
Amyotrophic lateral sclerosis (ALS) is a rare neurodegenerative disease. Current approved therapies, Riluzole (worldwide) and Edaravone (not in EU), increase patient survival by only a few months. ALS is a rare disease; however, the number of ALS cases is predicted to increase of almost 70% worldwide, reaching nearly 400,000 patients by 2040, largely due to the aging population, and the annual healthcare cost per ALS patient is among the highest for neurological condition. Among the research efforts at academic or industrial level in Phase II or III there are antisense oligonucleotides that modulate the aberrant RNAs of SOD1 and C9ORF72 in patients carrying specific mutations in these genes but an effective therapy for the broad spectrum of sporadic patients (90% of total ALS) represents a critical and urgent need.

TECHNOLOGY
A drug product to treat all forms of ALS by targeting an important pathogenic pathway regulated by a small RNA, miR-129-1, that was found up-regulated in both familial and sporadic ALS patients, and in the ALS mouse model. The modulation of miR-129-1 with an Antisense Oligonucleotide with Morpholino chemistry (ASO-PMO) in the early symptomatic ALS mouse model allowed for a 12.5% increase in survival and an improvement in neuromuscular performance and in key neuropathological hallmarks, while as of today the few therapies available for humans offer an average survival increase of 0.5-1%. This proposed patented drug outperformed, at preclinical level, when compared with other ALS approved molecules.

DEVELOPMENT STATUS
Further testing is in the pipeline to confirm the therapeutic advantage of the drug and to optimize it. To improve ASO-PMO biodistribution and therapeutic efficacy, an arginine-rich peptide, able to cross cellular membranes, can be conjugated to it. In addition, we plan to confirm its therapeutic efficacy in another preclinical model of ALS that better reproduces the sporadic phenotype of the disease and therefore could have a social impact in the broad spectrum of sporadic patients, before proceeding with pharmacokinetic and toxicological evaluation.

COMMERCIAL OPPORTUNITY
Seeking pharmaceutical companies working in the ALS and neurodegeneration field for co-development and investment in the technology to confirm and optimize the therapeutic efficacy of the drug and build the basis for clinical translation of a commercially viable product.

Contact the team via Knowledge Share

AEROSPACE

ADDITIVE MANUFACTURED UV CURED COMPOSITE PROPELLANTS FOR ROCKET PROPULSION

TECHNOLOGY READINESS LEVEL (TRL): 3/4

POLITECNICO DI TORINO

Team Delegate Simone Garino
Patent number 102019000005788
License INTERNATIONAL

CHALLENGE

In the current industrial landscape, solid composite propellants for missiles and space launchers are produced according to a rigid procedure. The shape given to the propellant is fundamental for the propulsive mission: it governs the variation of the thrust-time curve. Currently, only some well-defined shapes can be obtained from the mandrel forming system, due to extraction limits. The proposed invention allows for the formation of complex geometries, allows local chemical control of the propellant composition and eliminates the risks and costs associated with the production of large batches in a safer environment for the operators.

TECHNOLOGY

An innovative production process for composite propellant grains for rocket propulsion, in which the mixture is composed by solid components (e.g., oxidizer) and liquid (e.g., monomer or prepolymer) is layered and reticulated thanks to a photo polymerization process. The idea aims to relieve the propellant grain production process from the classical method, characterized by some limits, the greatest regarding the internal geometry configuration. In order to make it possible, more than one formulation has been developed, capable to fully polymerize in a very short time, thus allowing a continuous deposition process able to permit a detailed control on the final geometries; that has been feasible thanks to the usage of an UV photo polymerization procedure. It is thus possible to simplify the production process, reduce the costs, limit the presence of toxic compounds, enhance the degree of freedom and control over the project.

DEVELOPMENT STATUS

Further development at industrial scale needed. Aiming to consolidation of an innovative academic research on the additive manufacturing of energy materials, currently non-existent in Europe; industrial consolidation in the field of additive manufacturing proposing totally innovative production lines; and establishing leadership in Italy in the field of space propulsion for the ability to produce new engines with unique characteristics.

COMMERCIAL OPPORTUNITY

Finds best application in the field of propulsion, both for space and military purposes. The technology allows a detailed control of the thrust profile, thus mission control optimization. Seeking for collaborators with background in additive manufacturing and propellant production, to further refine and test the formulation of the propellant and validate the technology.

Contact the team via Knowledge Share

ANTI-ICE SYSTEM INTEGRATED IN PRIMARY AIRCRAFT STRUCTURE
TECHNOLOGY READINESS LEVEL (TRL): 6

POLITECNICO DI TORINO

Team Delegate Carlo Giovanni Ferro
Patent number 102016000098196
License INTERNATIONAL

CHALLENGE
Aerothermal systems are currently the standard for aircraft de-icing, using hot air bleed from the engine and implementing a series of complex sub-systems, such as hot air distribution pipes, cavities, stiffeners nozzles etc., which must be solidly joined to the structure of the aircraft through expensive and safety-critical operations such as riveting, gluing or welding. Furthermore, these devices require non-negligible air flow rates to be bled from the engine with an increase in fuel consumption and a reduction in engine performance. Exploiting new technologies, is possible to reduce weight, part number and overall costs with benefits in maintenance costs reduction, as well as less fuel consumption and less pollutant emissions.

TECHNOLOGY
Compared to the state of the art this patent introduces an innovative anti-ice completely integrated inside of the structure of the airplane. Its trabecular core works as impact absorber and embedded anti-icing/de-icing system. Beyond the thermal efficiency improvement, the global mass of the system is dramatically reduced. Moreover, the combination of energetic efficiency and lightness leads to sensible reduction in fuel consumption and gas emission. The airplane cost per hour will benefit of the single-piece philosophy (no welding, riveting, or gluing) with a reduced maintenance. Finally, by exploiting the full potentials of trabecular cores has been demonstrated that this solution dissipates better the energy produced by hazardous impact. The flexibility of additive manufacturing allows to applicate this patent to various part of the airplane with near zero manufacturing tooling variation.

DEVELOPMENT STATUS
This anti-ice system is currently at TRL 6. Both component design and testing in a relevant environment have been completed successfully. The strong partnership with Ellena Spa, a stakeholder of metal additive manufacturing in Italy, has permitted to scale up the industrialization up to the final component stage. The first prototype is ready for the test flight phase. The development of the sensors cluster of the panel for the stage2 is ongoing and forecasted for 2022. Optical and graphene sensors will be integrated inside of the anti-ice panel in order to create a smart component: sensors fusions will monitor both thermal and structural properties in real-time to provide the Aircraft On-Board Computer with active feedback on the system status. An algorithm of Machine Learning is in the developing phase to predict the residual life for targeted maintenance allowing further optimization in operative cost and maintenance time reductions.

COMMERCIAL OPPORTUNITY
The application can easily be extended to any aeronautical heat exchangers and industrial / chemical plants where structural and thermal functions (chemical reactors, drying processes, etc.) are jointly performed by the internal components.

Contact the team via Knowledge Share

ASSE: ANGEL OF ATTACK AND SIDESLIP ESTIMATOR
TECHNOLOGY READINESS LEVEL (TRL): 5/6

POLITECNICO DI TORINO

Team Delegate Angelo Lerro
Patent number 102020000000331
License INTERNATIONAL

CHALLENGE
Most aircraft accidents arise from the loss of control due to erroneous or missed perception of the stall condition. Stalling conditions are seen to be cause by the angle of attack as a function of the slide slip angle of the aircraft; conditions is not identifiable with traditional systems and it is highly acknowledged on ultralight aircraft.
After two accidents were sustained by the Boeing 737-MAX, EASA approved the application of synthetic (or virtual) sensors to improve the safety characteristics of civil aircrafts. A synthetic sensor fuses the already available flight data to provide an additional measurement of one or more flight parameters without using dedicated probes. However, current systems are vulnerable to atmospheric variations and perturbations, have a limited range of acquisition and require aircraft modifications to be installed in order to increase the redundancy. The patented technology, named ASSE, has the final aim of limiting the problems arising from stall condition, providing a redundant "synthetic" measurement of the quantities affecting this phenomenon.

TECHNOLOGY
ASSE is a synthetic sensor for aerodynamic angle estimation, which can be applied to any flying object since the method is universal and to exact-end, thus, it does not require calibration. The ASSE solution is able to calculate analytically aerodynamic angles in dynamic flight conditions independently from the aircraft type, the configuration and the flight regime. The angle of attack is safety-critical for the flight since it enables to identify the stall conditions.
The angle of sideslip is important, not safety-critical, to optimise the flight path and to calculate stall conditions during turns or lateral wind. The heart of the invention is the intuition to measure the aerodynamic angles exploiting time histories recorded by from two independent systems (air data system and inertial reference system). The ASSE plays the game on another field if compared with current physical sensors or state-of-the-art synthetic sensors because ASSE is an exact and universal solution.

DEVELOPMENT STATUS
As part of the "SAIFE" PoC project funded by Compagnia di Sanpaolo, a technological demonstrator of the ASSE technology was carried out in mid-2021 to verify its performance under laboratory conditions. Currently, work is being to conduct a flight investigation by the end of 2022. As far as the use of ASSE as a software module is concerned, a first exploratory activity with Leonardo - Aircrarft Division has already been completed with excellent results for the use of ASSE.

COMMERCIAL OPPORTUNITY
The forecasted time-to-market for the product delivery in partnership with a specialized company is about two years with most of the time related to the certification phase for civil flight. Implementation of the ASSE method on-board modern aircrafts will increase the safety aspects related to stall condition of civil flights without modifying the current structure and avoiding the installation of additional probes (or vanes). The same benefits will be achieved on next-generation aircraft such as urban air mobility, supersonic business jets or hypersonic transport aircraft.

Contact the team via Knowledge Share

HYBRIS: STRUCTURAL BATTERIES FOR ELECTRIC AIRCRAFT
TECHNOLOGY READINESS LEVEL (TRL): 6

POLITECNICO DI MILANO

Team Delegate Alberto Favier
Patent number 102016000114808
License INTERNATIONAL

CHALLENGE
Hybrid-electric propulsion for aircraft represents a promising alternative to more widespread internal combustion engines (ICE), especially for General Aviation aircraft. Currently, their growth is limited by battery performance. In particular, low weight-specific power and energy storage capacities impose a relevant toll on the overall weight of the aircraft, in spite of a moderate contribution to the energy amount stored for propulsion. By comparison, normal hydro-carbon (HC) fuel provides energy density figures which are larger by about two orders of magnitude.

TECHNOLOGY
Hybris is a hybrid-electric light aircraft designed with extensive use of structural batteries, capable of purely electric flight during take-off and landing phases, allowing drastic reductions of noise and CO2. The Hybris concept allows to significantly reduce the weight of lithium-ion batteries to be embarked by using structural batteries (SB) in the airframe. SB are composed of innovative multifunctional composite materials, consisting of a polymeric matrix reinforced by carbon fibres, able to withstand mechanical loads and, at the same time, to store electrical energy. Although their electric characteristics are not comparable to those of classic batteries, and mechanical properties are similarly lower compared to those of traditional carbon-fibre composites, the dual nature of SB discloses substantial advantages in terms of weight savings, thus performance.

DEVELOPMENT STATUS
Structural batteries, which constitute an enabling technology for the exploitation of the patent, are under advanced development in several laboratories worldwide. Currently, end-users for that technology are mostly automotive manufacturers, which enjoy a larger economical yield than the aviation field. Consequently, a further development of the patented invention can be driven by the strong motivation towards the achievement of a higher TRL, in turn an enabler for the application of structural batteries in the field of aviation.

COMMERCIAL OPPORTUNITY
The patent can be applied to aircraft in virtually all categories, including unmanned aerial vehicles, civil and military manned aircraft. Seeking cooperation with a manufacturer in the General Aviation category, with an interest for green aviation and in the design of a unique cost-effective and high-performing product. Such a cooperation would result in the production of a fully-fledged technology demonstrator, to be exploited for the development of the proposed technology in larger aircraft categories, thus enabling new possibilities in terms of lower environmental impact and costs in commercial aviation in the longer term.

Contact the team via Knowledge Share

NEAR-ZERO EROSION, ULTRA HIGH TEMPERATURE CERAMIC COMPOSITE
TECHNOLOGY READINESS LEVEL (TRL): 5/6

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Luca Zoli
Patent number 102016000008310
License INTERNATIONAL

CHALLENGE
The aerospace and hyper speed transportation markets rely on ceramic matrix composites based on silicon carbide and carbon; excellent structural materials for high temperature capable of operating without a cryogenic cooling system (e.g., metals). However, silicon carbide-based materials are limited to temperatures below 1400°C, whilst graphite-based composites withstand 3000°C but have limited durability, and are disposable for rapid ablation in oxidizing environments.
All these composites are characterized by an extremely time-consuming production processes (machine time 1-6 months) and costs (>> 500 EUR/Kg). The manufacturing processes of the current materials foresee a further treatment such as coating. Currently there is a rush to replace the production processes to produce materials by greener and time saving processes with attention to cost-effective to replace in particular carbon_carbon with high durable materials.

TECHNOLOGY
The patent concerns the design and manufacture of near-zero ablation/erosion fibre-reinforced ultra-high temperature ceramic matrix composite (UHTCMC) materials with the ability to withstand sudden temperature changes even above 1800°C, in particularly aggressive environments from a chemical and mechanical point of views, resulting therefore reusable or with a durability superior to currently used materials. The process, allows for the fabrication of materials with high added value in a short time, with regard to the eco-sustainable aspect of the process. From a technical point of view, the process is mainly based on 1) impregnation of carbon fibre fabrics with a mixture of ultra-high temperature ceramic phases powders and 2) consolidation by sintering.

DEVELOPMENT STATUS
A CNR spin-off (www.k3rx.com) is currently working on the production of batches or semi-finished products tailored for the R&D sectors of aerospace companies. At this stage, the company will achieve low earnings, whilst collecting commercial and technical information. Subsequently, the spin-off will obtain necessary certifications and new financial and marketing plans are going to be developed while revenue is expected from the development and manufacturing of components. Finally, based on the trends of the previous activities, the generation of customized offers of components for the actual production of potential customers and possibly the generation of standardized offers is assumed.

COMMERCIAL OPPORTUNITY
Fabrication of components of thermal protection systems and rocket motors for hypersonic vehicles such as leading edges, nosecones, tiles rocket nozzles and chamber inserts. Possibility of using implementing the patent for the production of discs for braking systems of high-speed trains or of civil/freight aircraft.
The intrinsic characteristics of UHTCMC materials can also lead to the development of components not known to date. In particular, every field in which the maintenance/replacement of current components is more expensive than moving to new, more performing, materials.

Contact the team via Knowledge Share

RENEWABLE SOURCES, ALTERNATIVE ENERGY AND WATER

BATTERY MANAGEMENT SYSTEM FOR REDOX FLOW BATTERIES
TECHNOLOGY READINESS LEVEL (TRL): 7

UNIVERSITÀ DEGLI STUDI DI PADOVA

Team Delegate Andrea Trovò
Patent number 102020000005263
License INTERNATIONAL

CHALLENGE
Redox flow batteries (RFBs) are devices for the storage of electric energy based on a reversible redox reaction. RFBs comprise a pile of cells, forming a stack. Each cell consists of a pair of half-cells, separated by a ion exchange membrane, which constitute the positive and negative electrodes. Two tanks store the positive and negative liquid electrolytes, each being circulated into the eponymous cell electrodes through hydraulic circuits and pumps.
Thou RFBs are robust in design and high performing, there are still some technological issues that need improvement, such as methods: to maintain the stored charge during long stand-by periods; to avoid the generation and precipitation of salts in the cells; to control the electrolyte temperature in the battery cells; to maximize the efficiency of the system, to minimized its costs.

TECHNOLOGY
To ensure continuous and stable electrical power supply from renewable resources, production plants must include large energy storage systems. RFBs are used for this purpose, but they require careful management to operate at maximum efficiency and to reduce operating and maintenance costs. This patented Battery Management System (BMS), consisting of both hardware and software, continuously monitors and controls temperature, fluid dynamics and state of charge of the battery. When a critical condition is identified, the system restores the optimal parameters, even during battery stand-by. In fact, when RFBs are inactive for prolonged periods of time, reversible and irreversible side effects can occur, as the precipitation of the electrolytes in the solution. This may reduce the system operability and damage to the battery. The innovative algorithm implemented in the BMS can guarantee the correct management of the electrolyte solution in all operating conditions. Optimal control parameters also improve the battery response time and reduce maintenance.

DEVELOPMENT STATUS
The BMS has been tested on an industrial scale battery facility in the Electrochemical Energy Storage and Conversion Laboratory of the Department of Electronic Engineering of the Padua University. The BMS software runs in LabVIEW but the software can be easily transferred to industrial PLCs at very low costs, allowing achieving TRL9.

COMMERCIAL OPPORTUNITY
This technology looks at the energy storage market, which is closely tied to the production of electricity from renewable resources. Electrochemical energy systems are more and more used in stationary applications from end-user, to microgrids, to DSO/TSO. To maximise the market impact of the invention, the team is looking for partners to industrialize the technology on the large scale.

Contact the team via Knowledge Share

LIFT ENERGY: FLUORINATED SURFACE COATING FOR LI-BATTERIES
TECHNOLOGY READINESS LEVEL (TRL): 4

POLITECNICO DI MILANO

Team Delegate Maurizio Sansotera
Patent number 102021000000704
License ITALY

CHALLENGE
The safe Lithium (Li) rechargeability is a chimera from the very beginning of lithium battery technology, because Li-metal rechargeable batteries could double the gravimetric energy density of current Li-ion batteries. However, dendrites formation during battery charge-discharge cycles lowers the stability and the safety of the Li-electrodes. A stable Solid Electrolyte Interface (SEI) improves a smoother Li deposition during plating and stripping processes, therefore avoiding dendrites growth. Thus, metallic Li can replace graphite-based electrodes for the assembly of new Li-metal rechargeable batteries.

TECHNOLOGY
LiFt Energy technology is a fast and scalable method to create a thin artificial SEI on lithium metal for its safe use in Li-rechargeable batteries. The SEI formation is inevitable in Li batteries and, conventionally, this problem is solved by modifying the electrolyte composition, generating a stable SEI during the long activation step of the battery. LiFt Energy technology creates a stable artificial SEI directly on the Li-electrode before assembling the battery and represents an approach never adopted before. It ensures a rapid, clean and safe treatment, with many advantages particularly in terms of performances improvement and simplification of the assembly process.

DEVELOPMENT STATUS
Several working prototypes have been realized and the electrochemical analysis highlighted a net improvement of the performances compared to the actual commercial batteries. The parameters of LiFt treatment can be properly modified depending on the requirements. Currently, the prototypes realized are button cells (CR2032) and pouch cells of different sizes. The aim for the next stages is the fabrication of an integrated system in which a group of batteries composed by the prototypes could confer better performances to portable batteries with small size, systems for eco-mobility, medium-sized energy storage systems, and lastly large vehicles, such as cars or trucks.

COMMERCIAL OPPORTUNITY
For the beginning of the sale activity, 18 months are required for further optimization and industrialization of the process. Known the exponential growth of the use of Li-based technology energy storages, this product and its applications could be used in a market that starts from microbatteries ending with both EHVs and EVs.

Contact the team via Knowledge Share

SINERGY: METAL-POLYSULFIDE REDOX FLOW BATTERY
TECHNOLOGY READINESS LEVEL (TRL): 4

POLITECNICO DI MILANO

Team Delegate Alessandra Accogli
Patent number 102020000011263
License ITALY

CHALLENGE
To achieve the full transition towards renewable power sources, the integration of various stationary energy storage systems is necessary. In this regard, it is estimated that storage devices with a limited duration (<10 hrs) will guarantee a penetration of solar and wind energy limited between 20-50%, while long-duration storage devices (>10 hrs) will increase this share up to 90%. Unfortunately, the dominant technology on the market, lithium-ion battery, is extremely penalized by the short life cycle, highly flammable components, poor sustainability, and strong geolocation of raw materials. On the other hand, within the redox flow battery scenario, the most common technologies exploit vanadium or zinc-bromine chemistries relying on expensive, rare, or toxic elements, reducing their penetration on the market, especially for high energy-to-power ratio applications. In this context, systems other than electrochemical storage ones are currently used, such as pumped-hydro and compressed air, both limited by geographical constraints, high costs for infrastructures, and low response time.

TECHNOLOGY
The invention consists of a metal-polysulfide redox flow battery based on low-cost, Earth-abundant, and non-toxic materials, crucial features for the sustainable energy transition. Moreover, a further advantage is the possibility to exploit sulfur-rich by-products from oil and natural gas refining processes, following a fully circular economy approach, and reducing the environmental impact of the technology. The low installation cost (30 -150 $/kWh) meets the economic feasibility requirements for the massive integration with renewables, especially under long-duration energy storage operations i.e. continuous charge/discharge time >10 hrs. The integration of such devices would allow the effective penetration of renewable sources in the energy production system up to 90 %. The low cost, high versatility, and durability of the technology make SINERGY suitable for both front-of the- meter and behind-of-the-meter applications, thus increasing the reliability and sustainability of the electrical grid.

DEVELOPMENT STATUS
Thanks to €120k raised by the "S2P Innovation Challenge 2020", ENI Joule Special Grant, Startcup Lombardia 2021, Everis Foundation Award, and Piano Nazionale Innovazione 2021, the next R&D activities will be focused on the development of a medium-scale (1-2 kW, 5-10 kWh) prototype and the subsequent integration with a PV-panels and a battery management system. Additional funds would ensure the development of a pre-commercial module (10 kW,> 100 kWh) for the on-field test in a relevant environment.

COMMERCIAL OPPORTUNITY
This groundbreaking technology will thrive in the stationary energy storage market, accounting for $ 9 bln in 2019 and estimated to reach $ 100 bln in 2030, in which redox flow batteries will penetrate the market up to nearly 7 bln in the same year with 46 GWh installed. The invention is addressing the needs of those companies active in electricity production and distribution, as an innovative solution supporting clean energy generation and smart management.

Contact the team via Knowledge Share

SMARTWIND: «SMART» INERTIA EMULATION FOR WIND GENERATORS
TECHNOLOGY READINESS LEVEL (TRL): 4/5

UNIVERSITÀ DEGLI STUDI DI GENOVA

Team Delegate Andrea Bonfiglio
Patent number 102018000007930
License INTERNATIONAL

CHALLENGE
The progressive diffusion of non-inertial renewable generation such as photovoltaic and wind is causing a weakening of the electricity system by means of the reduction of the system electric inertia. The rate of change of frequency is the indicator of this issue and in case of major events such as loss of generation units or boarder lines it may suffer sever transients with risk of malfunctioning and black-outs. Unlike traditional power plants, wind turbine generators are not able to provide inertial frequency support in a natural way and thus dedicated upgrades needs to be studied in order to cope with this problem.

TECHNOLOGY
SMARTWIND technology is an auxiliary controller that enables wind power generation to inertial frequency support in an effective and optimized way. This support is provided exploiting the kinetic energy of the wind turbine rotor. The innovative elements of the technology are (i) the efficient usage of the wind turbine kinetic energy in order to avoid undesired disconnection of the generator due to speed cut-off, (ii) the control of the rotor speed recovery phase once the frequency support action is finished and (iii) the definition of a management logic of the operational phases of the service. More in details, SMARTWIND technology allows to adapt the action of the support managing it according to the turbine rotor speed reduction and nullifying it before the lower limit value of the rotor speed. This allows maximizing the support action and avoiding an undesired disconnection of the generator that would cause a negative impact on the system frequency. The technology also distinguishes if the system frequency is still in a critical phase when the support ends, if this is the case, the speed recovery shall be slower to minimize the impact on the grid. Finally, an advance logic capable to detect the need of frequency support and manage the switch between the frequency support phase and the rotor speed recovery one is provided, a very important aspect for a real implementation of the service.

DEVELOPMENT STATUS
A prototype of the technology made with market available devices has been realized in the frame a recent proof of concept project. It was tested and validated in a Hardware in the Loop set-up by means of real time simulations highlighting the feasibility of the proposed architecture and the effectiveness of the control to support the system frequency. The positive results of this project allow considering further developments of the technology with the aim of taking the prototype at an industrial level.

COMMERCIAL OPPORTUNITY
The technology is suitable for both newly realized wind power plants and existing ones, and thus benefits of wide commercial opportunities. The characteristics of the patent may also be appealing for customization for battery energy storage systems. This can be considered as a non-negligible secondary business in the light of the increasing number of storage-based applications.

Contact the team via Knowledge Share

FINAPP®: WATER SENSING WITH COSMIC RAYS
TECHNOLOGY READINESS LEVEL (TRL): 8/9

UNIVERSITÀ DEGLI STUDI DI PADOVA

Team Delegate Luca Stevanato
Patent number 102019000000076
License INTERNATIONAL

CHALLENGE
Trivial as it may seem, measuring water is not that simple. The water present in the soil, in the biomass, in the snow vary significantly even at short distances due to the heterogeneity of the soils or snowpack. All point-scale water measurement, even if accurate, have the great limitation of not being representative on a large scale. Satellite remote sensing overcomes this limitation, but it is not suitable for measuring the water content in depth, but only to return a superficial picture. Cosmic ray neutron sensing – CRNS - technology is able to provide the water content on large scale – few hectares – and in depth – 50 cm into the soil, meters into the snow, but CRNS probes based on gas detector have a high price tag and cannot supply real time data, limiting their use within laboratories. Finapp®'s new generations of CRNS probes overcomes all these limitations, by providing a reliable, less expensive, real time water content measure, suitable for agricultural and environmental monitoring.

TECHNOLOGY
A device and a process for measuring in real-time the water content of the soil, vegetation and snowpack on a large scale. Compared to the systems currently on the market (electromagnetic sensors, remote sensing, environmental neutron detectors) it is more effective, reliable and less expensive. The invention uses a system for detecting environmental neutrons induced by cosmic rays: there is in fact a correlation between the flux of neutrons and the average water content of the soil, vegetation and snowpack. The patented system offers the advantage of being able to provide data relating to a few hectares of surface, and up to 60 cm in depth, thanks to a much less expensive detection probe than those available on the market. The data obtained in real time will be particularly useful in agriculture, for planning precision irrigation, as well as for use in the climatological, hydrogeological and meteo-nivological monitoring.

DEVELOPMENT STATUS
The patent is licensed to the Spin-Off of the University of Padua "Finapp srl". Numerous installations of the apparatus are in place in Italy and Abroad. From these installations the positive impact of the technology will be further defined.

COMMERCIAL OPPORTUNITY
The detector can be used in agriculture by installing it in the cultivation field, thus allowing it to be prepared for the use of fertilizers based on the permeability of the soil. The technology is also useful for measuring the density of snow, this application allows to predict the amount of water that will melt as the temperature rises, such knowledge helps predict the amount of energy that a hydro-electric power plant will produce during the year. Furthermore, this device installed on a moving vehicle can detect water leaks from aqueduct underground pipes along many kilometres.

Contact the team via Knowledge Share

FUTURE MOBILITY

CONTACTLESS MAGNETIC GEARBOX WITHOUT CLUTCH
TECHNOLOGY READINESS LEVEL (TRL): 4

POLITECNICO DI TORINO

Team Delegate Elvio Bonisoli
Patent number 102020000017512
License INTERNATIONAL

CHALLENGE
The gearbox is a key component of a vehicle power transmission, compromising of classical mechanical gears requiring the use of a clutch to allow the decoupling of rotating elements during gearshifts; components which are particularly subject to wear. The proposed invention enables the integration of the clutch and of torque limiter functions inside the gearbox itself, avoiding the mechanical interactions. It solves the problem of gear engagement vibration and noise, allowing the torque transfer between input and output without contact between mechanical components. Contactless transmission avoids wearing and the necessity of lubricant oils, ensuring a longer life to the system and an environmental benefit with the reduction of polluting materials.

TECHNOLOGY
The magnetic gearbox consists of a certain number of coaxial magnetic gears equal to the number of desired gear ratios. The internal rotor is connected to the power source and rotates at its own speed, whilst the external rotor is connected to the user-end and turns at a speed determined by the transmission ratio of the selected gear. The intermediate element, containing ferromagnetic poles, is subject to an axial translation, allowing the torque transfer between inner and outer rotors with the desired transmission ratio. Dimensions of the magnetic gearbox and its elements (magnets, ferromagnetic poles, airgap) can be optimized to reduce the overall dimensions in order to increase the torque transfer capability between input and output of the system. Multiple topological variations can also be considered. Thus, a magnetic gearbox system can be used with several advantages in the application fields where it is necessary to vary the transmission ratio between the output of a mechanical power source and the input of a generic user device, hence modulating the transmitted power as a product of torque and rotation speed.

DEVELOPMENT STATUS
A demonstrator prototype is currently available, it will be further validated in terms of torque conversion in stationary gear ratio conditions, already demonstrated in simulations, and to evaluate the optimal gearshift transient behaviour between two different transmission ratios with an appropriate control strategy through dedicated sensors. A collaboration is sought with automotive companies interested in the industrialisation of the prototype, and to further develop the design into a specific two-speed gearbox suited for light hybrid or pure electric vehicles.

COMMERCIAL OPPORTUNITY
The proposed invention could be used in various industrial sectors, including industrial automation, robotics, aerospace, military and wind energy. Applications in the automotive field, are certainly the best suited, where further development of the gearbox can lead to its use with internal combustion engines, hybrid and fully electric vehicles.

Contact the team via Knowledge Share

LOW-POWER MAGNETOMETER FOR IMPROVED SENSORS INTEGRATION IN FUTURE VEHICLES
TECHNOLOGY READINESS LEVEL (TRL): 3

CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)

Team Delegate Federico Maspero
Patent number 102020000007969 - PCT: WO2021209891 A1
License INTERNATIONAL

CHALLENGE
Electric cars, autonomous driving and drones will have a key role in future mobility. Conventionally, Lidar, magnetic sensors and inertial sensors are used for electronic stability of the vehicle. Magnetic field sensors and inertial sensors are based on two different technologies. The first uses magneto-resistive technology, in which the value of field-depended resistor is measured, while the second is based on micro-electro-mechanical-systems (MEMS) with capacitive actuation and detection. Here we propose, a MEMS magnetometer to ease the integration between magnetic sensors and inertial sensors, offering both high performance (e.g., sensors alignment), with low power consumption and possibility of integration into existing processes.

TECHNOLOGY
The MEMS magnetometer is composed of three main elements: a MEMS resonator, a permanent magnet and a pair of magnetic flux concentrators (MFCs). The permanent magnet is patterned on the moving element and placed in proximity of the MFCs. The flux concentrators convey the external magnetic field and produce a magnetic field gradient in the region of the permanent magnets. The force generated by the interaction of the magnetic field gradient and the magnets induces a frequency shift of the MEMS resonator. Such variation can be detected by the electronics coupled to the sensor and used to compute the incoming magnetic field. The MEMS magnetometer can be fabricated with standard industrial MEMS processes and be integrated with existing inertial sensors (accelerometers, gyroscopes), enabling a fully-MEMS inertial measurement unit, reducing the integration problem of MEMS sensor with magnetic sensor and obtaining a compact and high-resolution sensor with low power consumption.

DEVELOPMENT STATUS
The patent has been extended internationally, whilst, in the next 6 month the device will be fully characterized and further bench-testing conducted. Within one year, the team foresees the on-boarding of an industrial partner, for prototype production to meet industrial standards, for further validation, and subsequent commercialization.

COMMERCIAL OPPORTUNITY
Licensing the technology to a company operating in the MEMS and microelectronic business. This technology would bring the most benefits upon its integration within drones, as these require low power consumption of the mounted electronics in order to extend the flight range and make large use of inertial measurement units for electronic stability control. The possibility of single-chip fully-MEMS IMUs can offer a reduction of cost and size together with an improvement of alignments between sensors.

Contact the team via Knowledge Share

RECONFIGURABLE RADIO FREQUENCY DISTRIBUTION NETWORK
TECHNOLOGY READINESS LEVEL (TRL): 4

UNIVERSITÀ DEGLI STUDI DI PERUGIA

Team Delegate Valentina Palazzi
Patent number 102018000006163
License ITALY

CHALLENGE
Reconfigurable microwave components are in high demand in next generation telecommunication systems (5G and beyond). This has pushed research towards the development of reconfigurable beam-forming and power divider networks. However, accomplishing such systems with high flexibility has proven to be extremely difficult.
To overcome the shortfalls of these devices, a new microwave network, with unprecedented degrees of reconfigurability is presented.

TECHNOLOGY
The device consists of a radio frequency power dividing and phase shifting network, having a single input and a plurality N of output ports, which makes it possible to distribute the input signal on a subset n of the N output ports, in a selective and reconfigurable way, while ensuring matching conditions to all ports. The magnitude and phase control of the output signals is pursued only by varying the phase condition of variable phase shifters present in the circuit. Unlike conventional switching networks and common reconfigurable power dividers, where the signal is switched from one line to another, this device allows the incident radiofrequency signal at the input port to be distributed to the whole network. This approach permits an arbitrary power division ratio, as well as the simultaneous control of the amplitude and of the phase relationship between the signals at the ports.

DEVELOPMENT STATUS
A working prototype of the device is available. Furthermore, development of a miniaturized version of the device, and optimisation for specific applications is being conducted. Looking at the evolution, the team will develop a beam-forming network for circular antenna arrays. Collaboration is also sought with telecommunication experts and with vehicle manufacturers to develop a prototype able to improve the reliability of communication systems and to be integrated within a said system. Collaborators in the communication and satellite sectors is of interest to test the performance of the device with amplifiers with variable gain.

COMMERCIAL OPPORTUNITY
Thanks to its high reconfigurability, the device can be used to create variable gain amplifiers, highly reliable redundant systems and beam-forming network for reconfigurable antennas.

Contact the team via Knowledge Share

SELF-CONFIDENT: ONLINE LEARNING FOR DETECTING DEPTH SENSORS FAILURES
TECHNOLOGY READINESS LEVEL (TRL): 3

ALMA MATER STUDIORUM – UNIVERSITÀ DI BOLOGNA

Team Delegate Matteo Poggi
Patent number 102020000016054
License ITALY

CHALLENGE
Several systems acquiring 3D data by measuring the depth of an image are available on the market, including stereo cameras accompanied with algorithms. Despite the steady progress of such devices and algorithms, any of them suffer of specific limitations. In order to avoid faults, often resulting in dramatic consequences in applications such as autonomous driving or industrial robotics, it becomes crucial to detect when sensors fail at measuring depth.

TECHNOLOGY
Our technology faces this problem by estimating a confidence value of any depth measurement provided by a sensor, the higher the more reliable. This is carried out by means of self-supervised deep learning. Specifically, our framework consists of a deep neural network trained to estimate such confidence, without the need for any human-made or external data annotation. The network itself is indeed trained by means of geometric reasoning on images and their estimated depth, thus being fully self-supervised. The information allowing for training comes from the very same inputs processed by the network. Thus, it is available at any time during deployment and allows for continuous, online training of our solution. Coupled with any existing device collecting images and depth, our solution learns during the sensor usage and self-adapts to new environments.

DEVELOPMENT STATUS
Our technology faces this problem by estimating a confidence value of any depth measurement provided by a sensor, the higher the more reliable. This is carried out by means of self-supervised deep learning. Specifically, our framework consists of a deep neural network trained to estimate such confidence, without the need for any human-made or external data annotation. The network itself is indeed trained by means of geometric reasoning on images and their estimated depth, thus being fully self-supervised. The information allowing for training comes from the very same inputs processed by the network. Thus, it is available at any time during deployment and allows for continuous, online training of our solution. Coupled with any existing device collecting images
and depth, our solution learns during the sensor usage and self-adapts to new environments.

COMMERCIAL OPPORTUNITY
Estimating the confidence of a depth sensor from scratch is highly desirable for most real applications, yet such information is often not provided by commercial devices. The self-supervised nature of our technology allows for seamless coupling with any existing sensor, learning over time to detect its failures during its usage. Moreover, the online training performed by our solution continuously increases the confidence accuracy, making it a more and more valuable product over time.

Contact the team via Knowledge Share

THEO: DRIVER-ADAPTIVE, HEV ENERGY MANAGEMENT SYSTEM
TECHNOLOGY READINESS LEVEL (TRL): 4

POLITECNICO DI TORINO

Team Delegate Pier Giuseppe Anselma
Patent number 102020000008686
License INTERNATIONAL

CHALLENGE
There is urgency worldwide to decrease of vehicle on-road emission. Hybrid electric vehicles (HEVs) are presented as one of the solutions that can lead to fuel savings and tailpipe emissions. However, due to their complexity, HEVs require extremely defined energy management systems to be embedded within their on-board electronic control unit's system. Among on-board energy management systems, rule-based ones are most widely used, thanks to their ease of implementation, but are no adaptable to different driving scenarios, thus not achieving optimal fuel savings. This invention aims at reducing the fuel consumption and tailpipe emissions of HEVs by implementing a real-time energy management system capable of optimally adapting to the driving style of the current user.

TECHNOLOGY
The system includes an advanced control unit for hybrid powertrains that can edit the implemented control algorithm as a function of the specific driver before starting a new journey. It also includes an interface (e.g., haptic, visual) through which the driver can identify in the vehicle control system, and a storage system (either physical or virtual) for the Artificial Intelligence agent representing the HEV tailored control algorithm. Once the driver is identified by means of the interface, the system extracts the tailored HEV control algorithm from the storage system and loads it into the advanced HEV supervisory control unit, thus allowing the subsequent optimization of the HEV powertrain operation during the journey. The potential product could find application on a wide variety of HEVs (e.g., passenger cars, light-duty or heavy-duty vehicles). Among these, preliminary results implemented on a hardware-in-the-loop test platform have proved the capability of the technology of reducing by 1.6% the fuel consumption produced by a subcompact crossover SUV.

DEVELOPMENT STATUS
The first hardware-in-the-loop prototype of the technology has been implemented thanks to a Proof-of-Concept grant financed by the Politecnico di Torino. AVL Italia SRL has shown its willingness to support the activity through the provision of methodologies and tools necessary for validation, as well as through support for the identification of market interests related to the proposed technology. Once the results of further prototype massive testing will be available, the best solution for finalizing the technology on the market will be exploited.

COMMERCIAL OPPORTUNITY
The proposed invention can be implemented in hybrid electric road vehicles, a market in constant growth.
In the coming future, a potential foundation of a start-up is envisaged, that would manage the production and sale of the adaptive fuel consumption and tailpipe emission reduction system for hybrid electric vehicles to automotive manufacturers (OEMs) and their first-tier suppliers (TIER1s).

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