



ASSOLOMBARDA
Confindustria Milano Monza e Brianza

Hydrophobin-stabilized microbubbles

Microbolle d'aria stabilizzate da film proteici per applicazione come schiumogeni ed agenti di contrasto

Speaker

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12 ottobre 2016



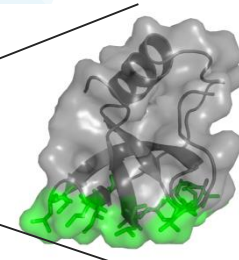
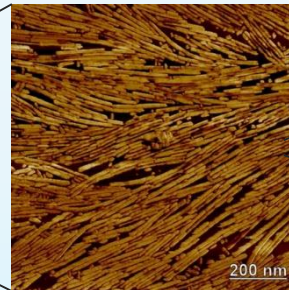
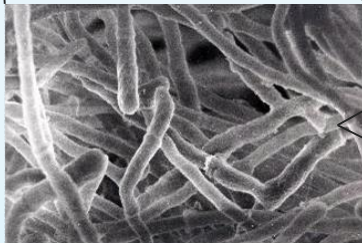
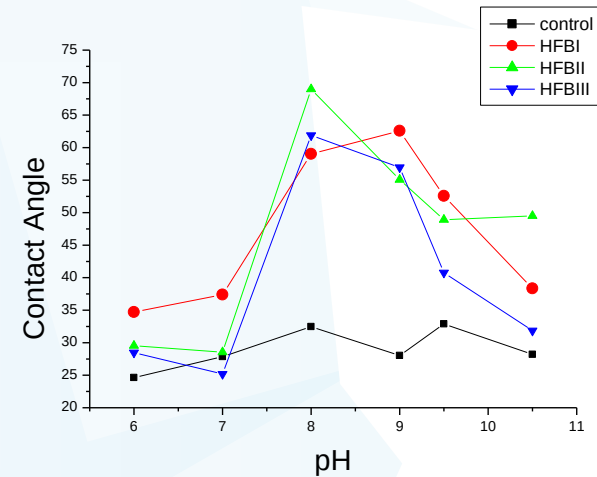
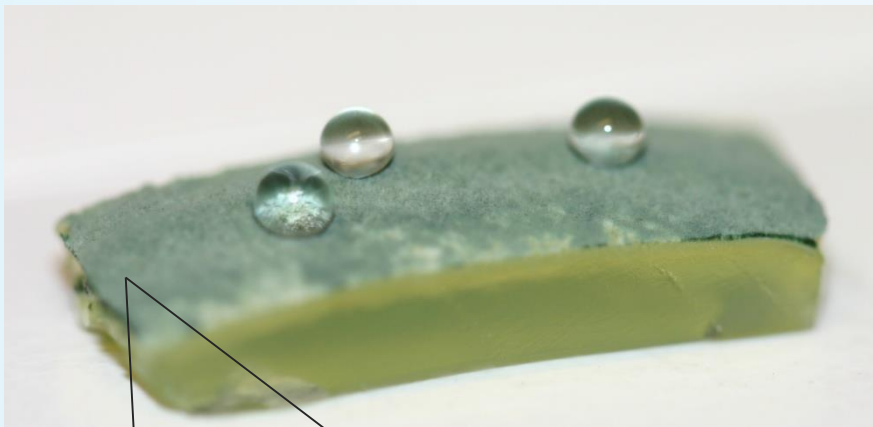
NFMLab – DCMIC “Giulio Natta”

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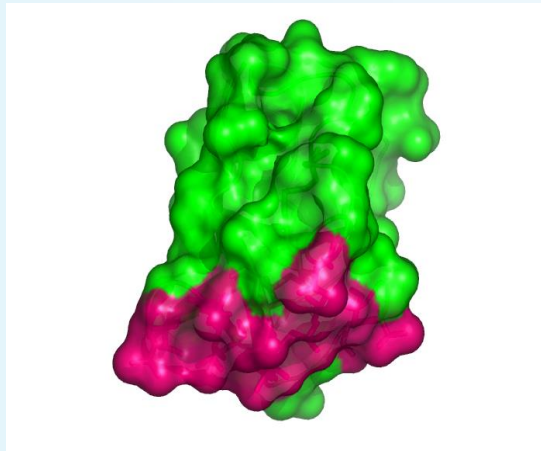
Hydrophobins

- They are key components in surface hydrophobicity of growing fungi (*Trichoderma Reseei*)



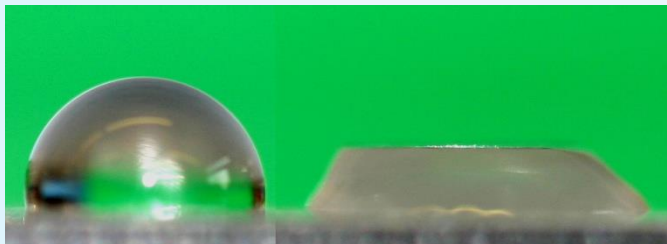
Hydrophobins

- ✓ Hydrophobins (HFBs) are small **amphiphilic, film-forming proteins**
- ✓ They can be seen as **natural Janus-type particles** (hydrophilic/lipophilic patches)



Area of patch 4 nm², total 32 nm².

Spontaneously in ~30 min:

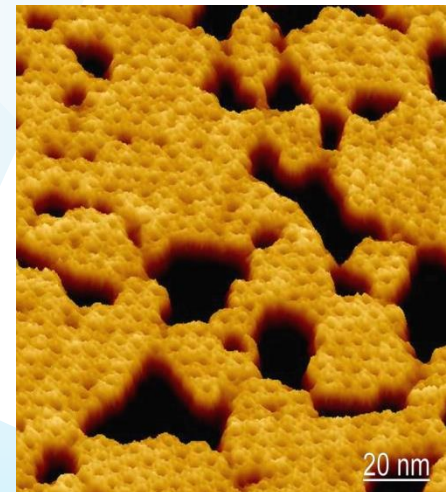
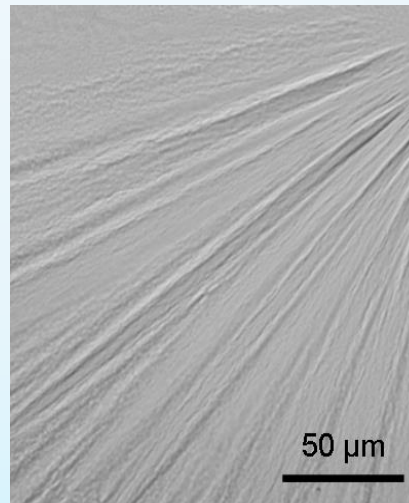
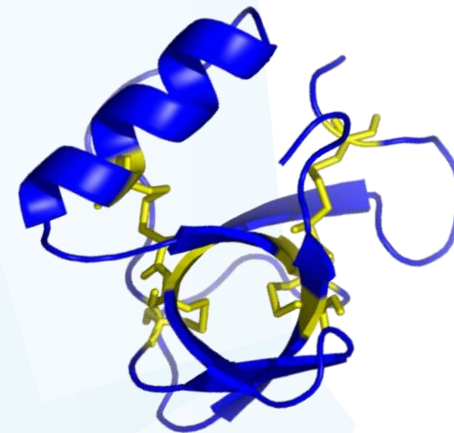


H₂O

HPB 10 µg/ml in H₂O

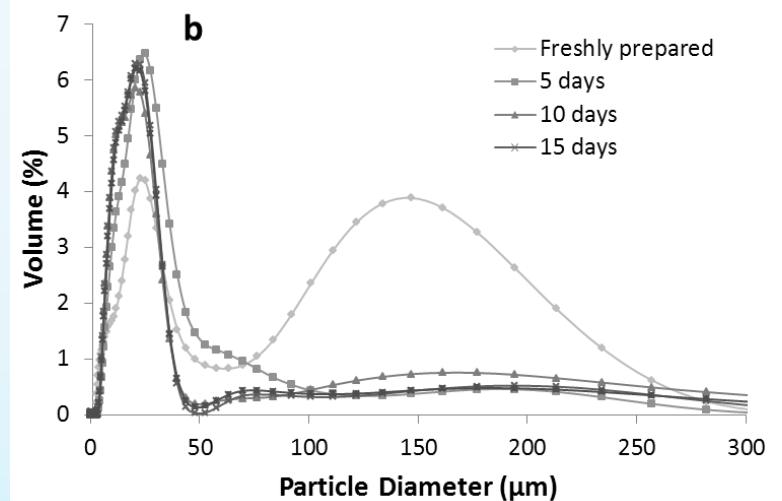
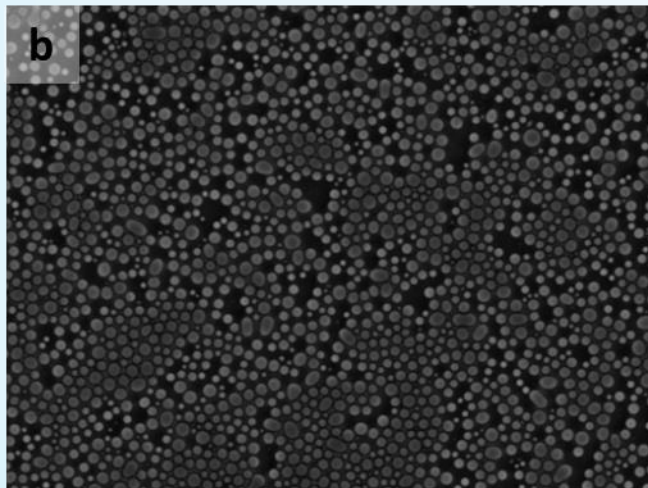
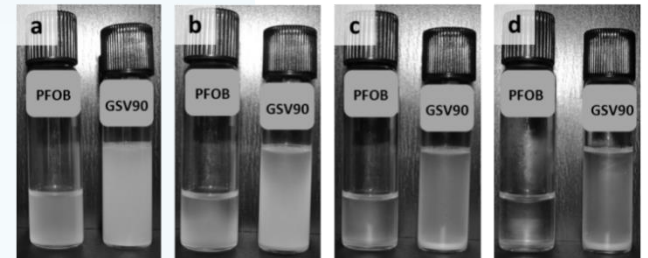
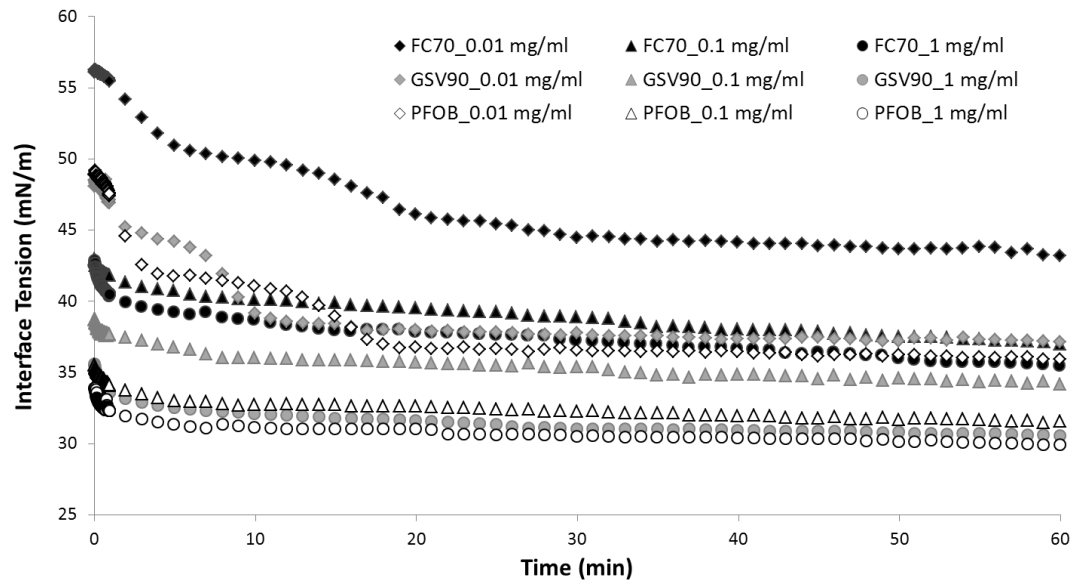


SDS



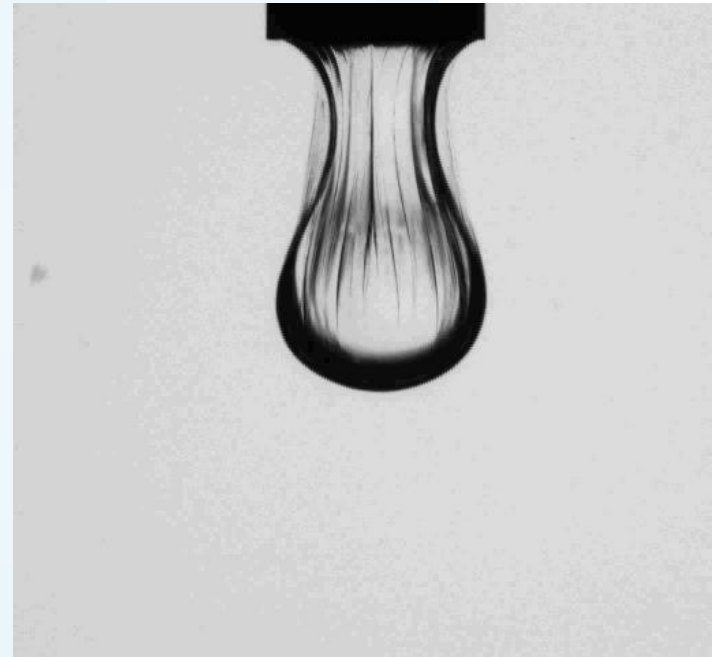
Fluorous Surfactants without Fluorine!

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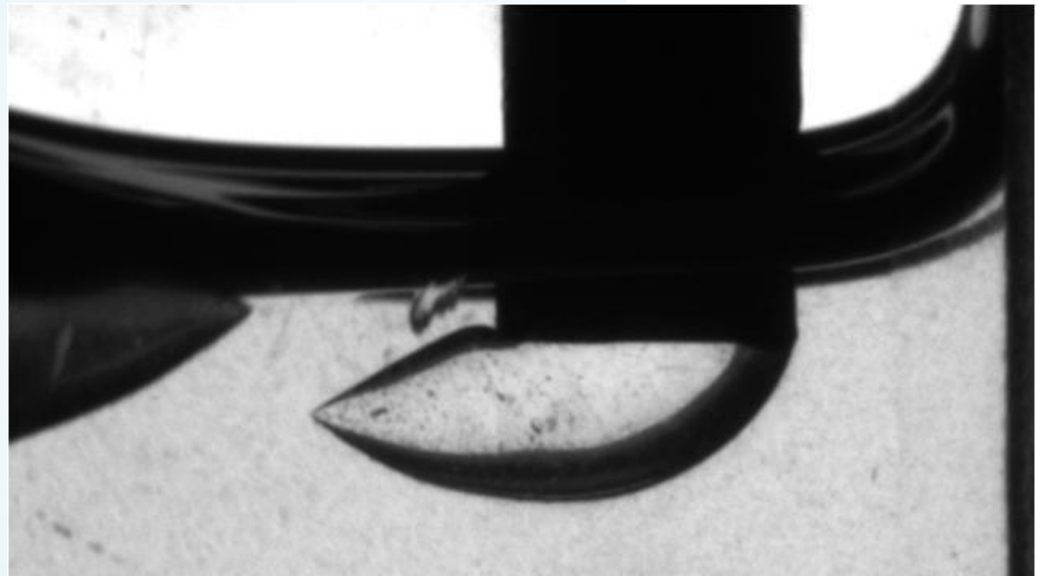
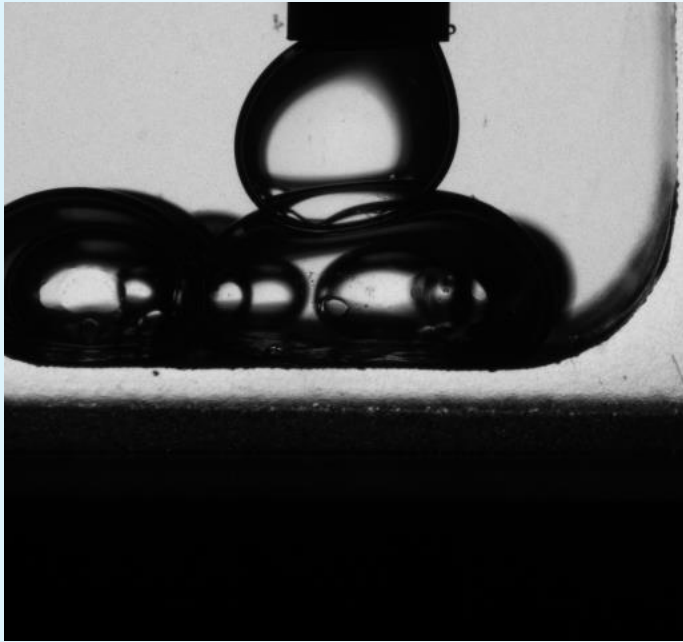
Film Formation at the W/F Interface

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- ✓ A **robust and elastic protein film** is almost instantaneously formed at the interface between the Galden droplet and surrounding water

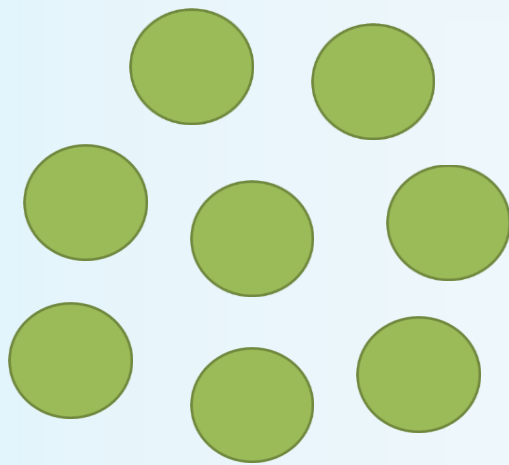
Give Water a Shape!



- ✓ The film is strong enough to **prevent droplet coalescence** under moderate pressure

Strategy

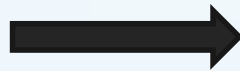
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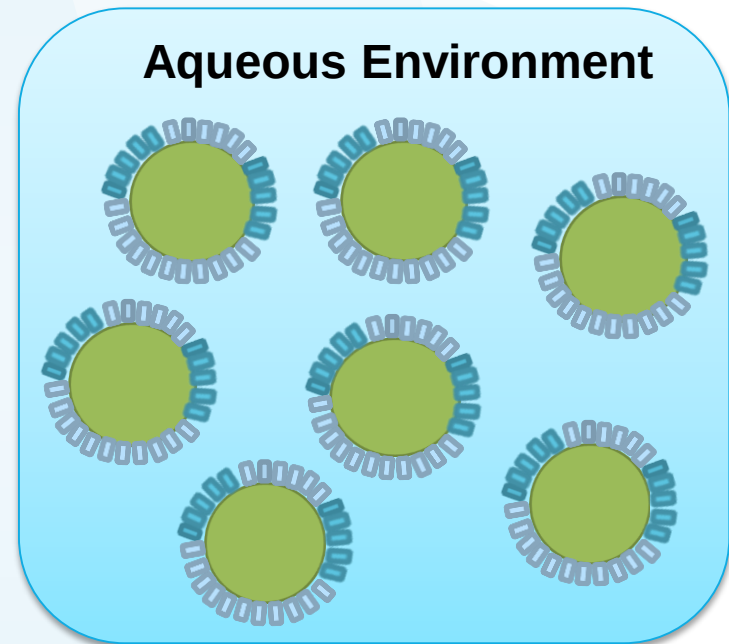
Powders of PVDF



Hydrophobin
solution



Tip sonication

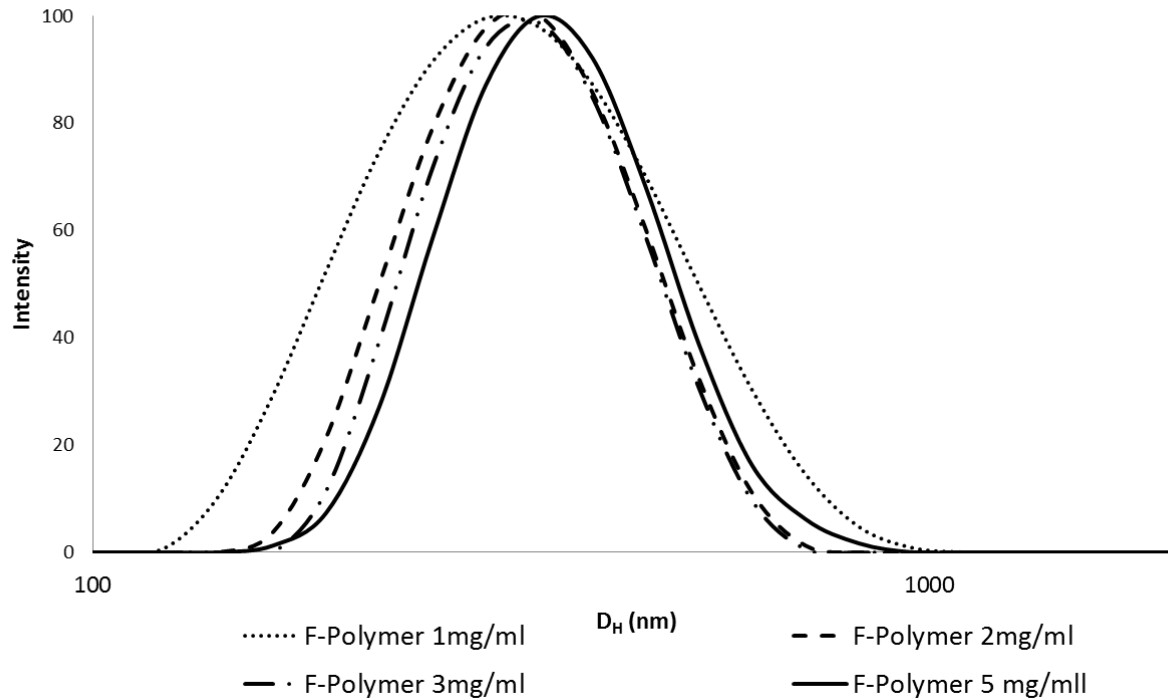


Objective: Stable water dispersions on PVDF in water using HFB.

Stable PDVF dispersions in Water

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Partially fluorinated NPs after proteic coating(mQw)



Methodology:

- Vortex
- Ultrasounds
- 24h equilibration

PVDF concentration	Cumulant	PDI
5 mg/ml	340 ±5.5	0.116 ±0.016
3 mg/ml	333 ±5.5	0.145 ±0.068
2 mg/ml	316 ±4	0.065 ±0.016
1 mg/ml	297 ±4	0.128 ±0.018

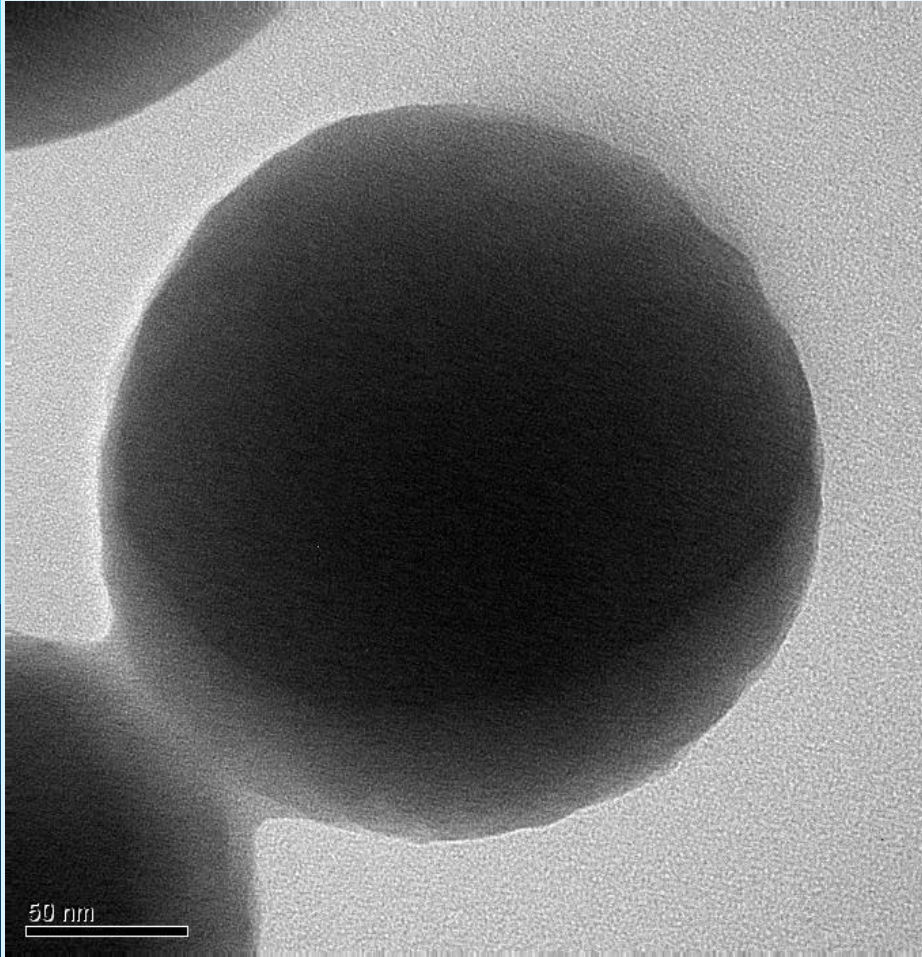


Four concentrations of polymer successfully dispersed in water

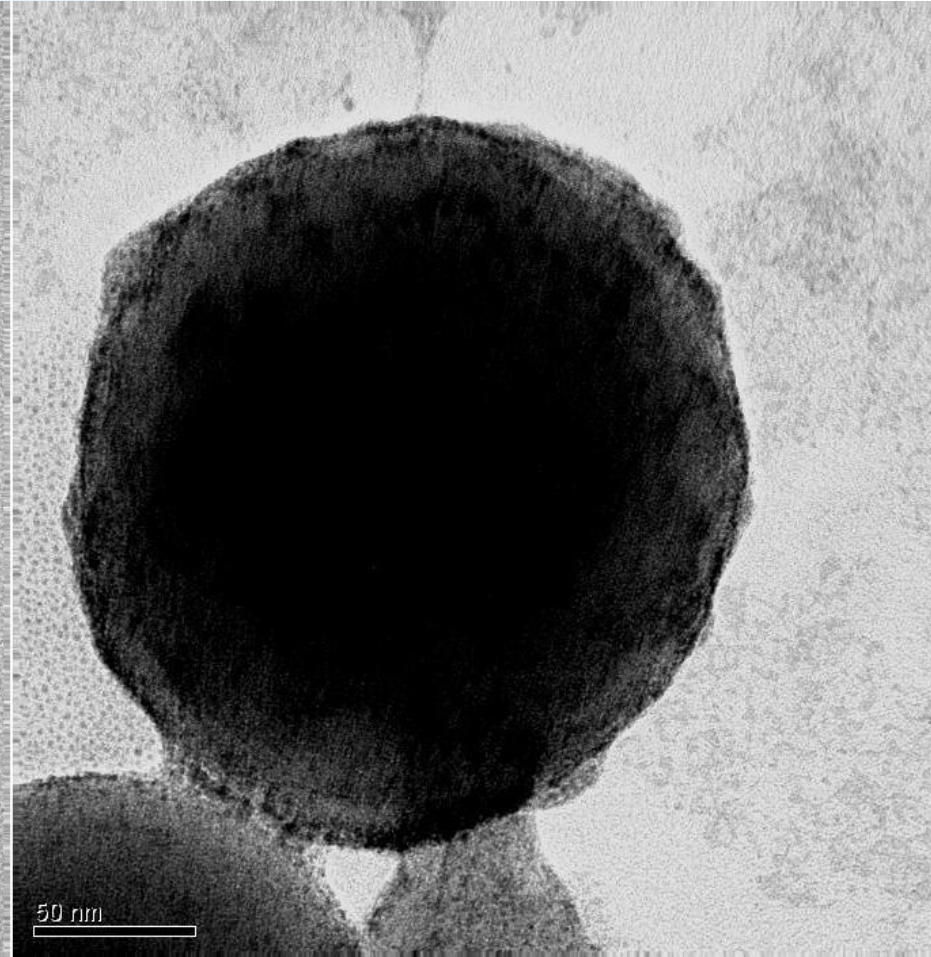
HFB-coated PDVF NPs in Water

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TEM



Before coating

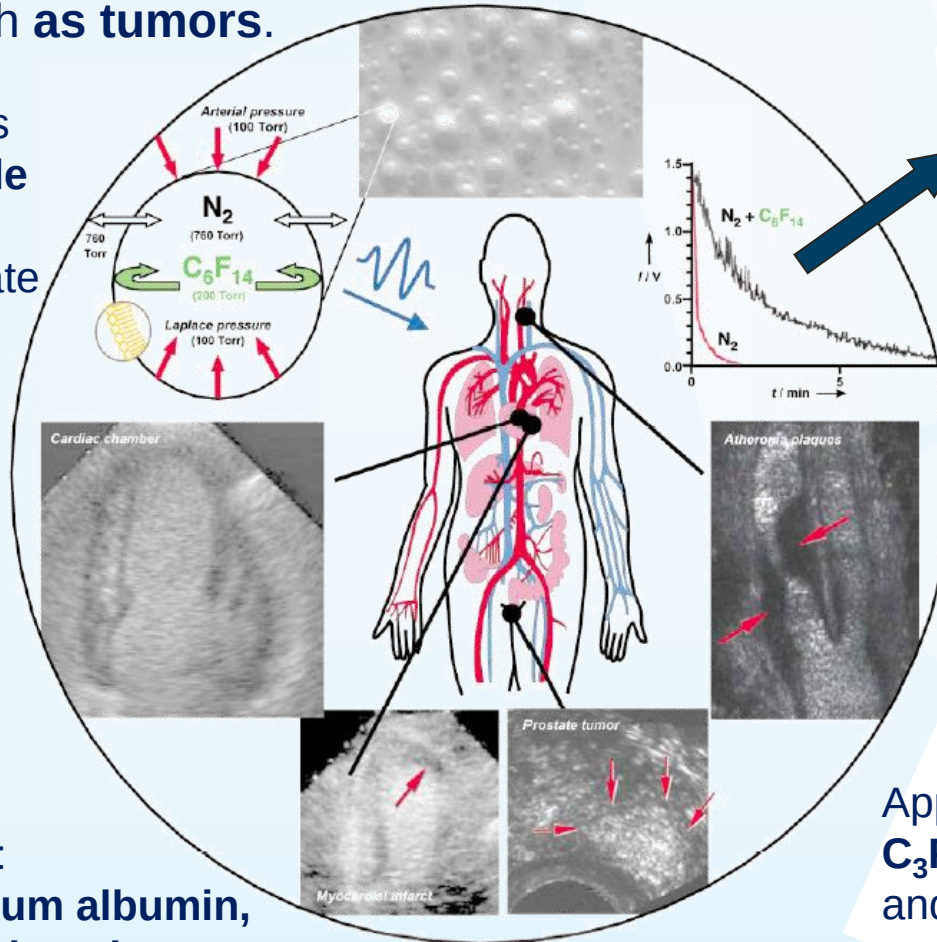


After coating (Uranyl acetate staining)

Fluorinated Gas μ Bubbles for US-Imaging

Aqueous dispersions of **micrometer-sized gas bubbles** that resonate at a diagnostic frequency are ideal reflectors for ultrasound. These agents allow the **detection and characterization of cardiovascular abnormalities** and **solid organ lesions, such as tumors**.

The shell that encloses the bubbles **can impede** the ability of the microbubbles to resonate



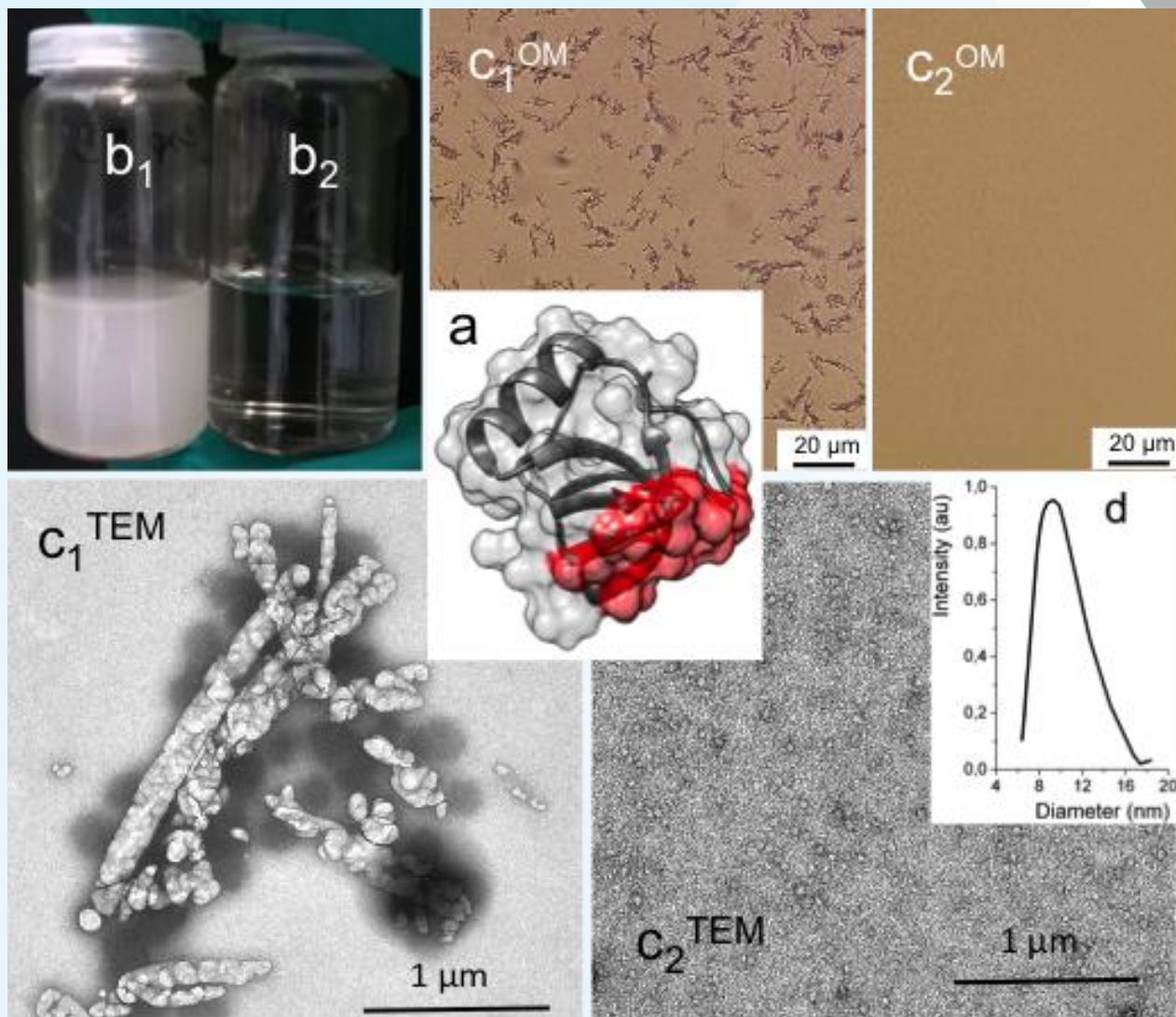
Simple air bubbles, when injected into the blood stream, disappear within seconds.

Use of fluorocarbon vapor, extend the persistence of microbubbles in vivo from seconds to minutes.

Common shells include:
denatured human serum albumin,
biodegradable synthetic polymers,
phospholipid membranes

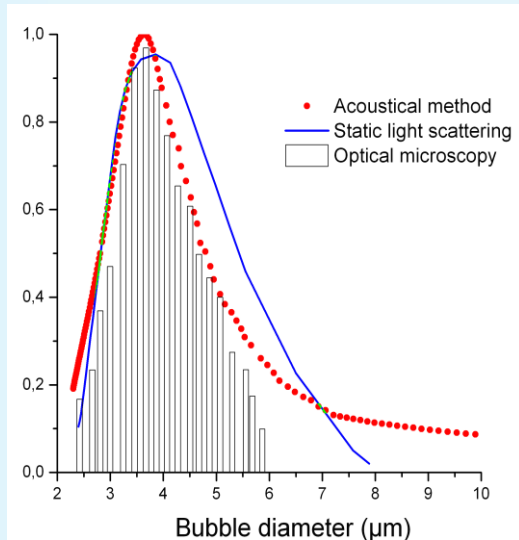
Approved products:
 C_3F_8 or SF_6
and N_2 microbubbles
osmotically stabilized with
 C_6F_{14} .

HFBII Stabilizes Fluorinated Gas μ Bubbles

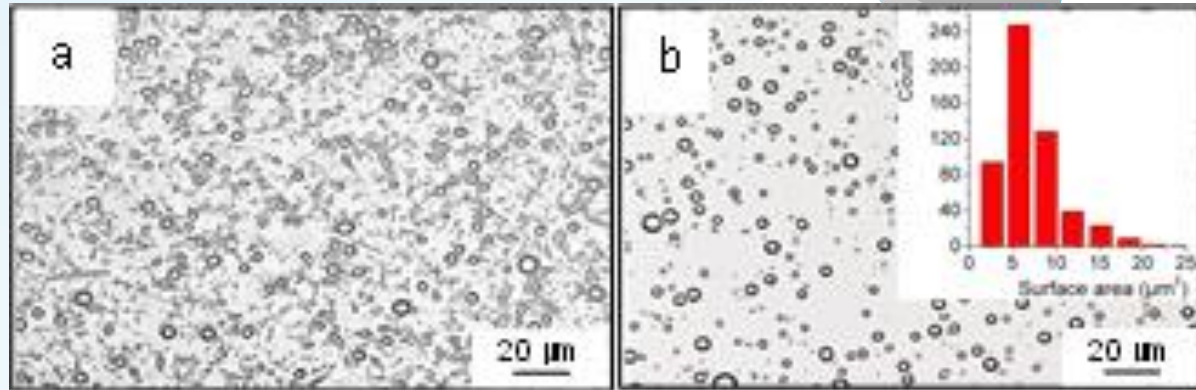
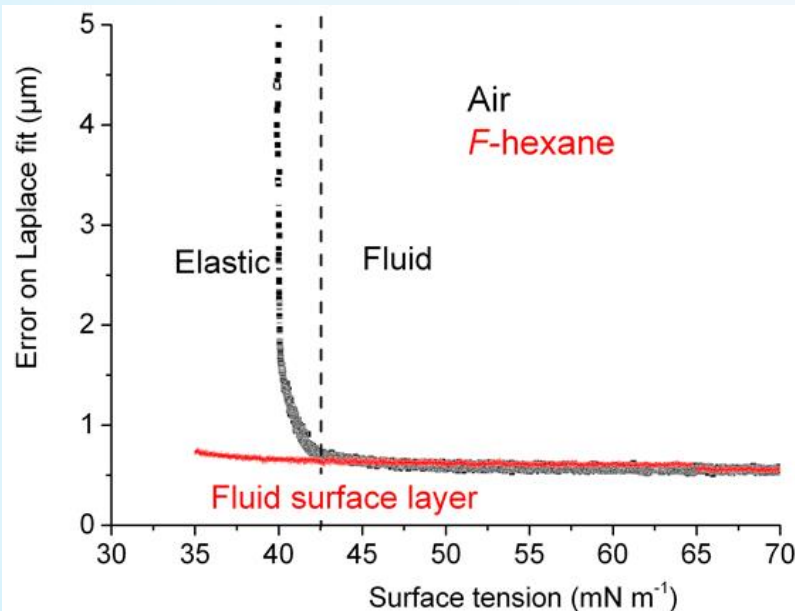


Angew. Chem. Int. Ed. **2016**, 55, 10263-10267.
PCT/IB2016/054181 (priority date: 07 August 2015)

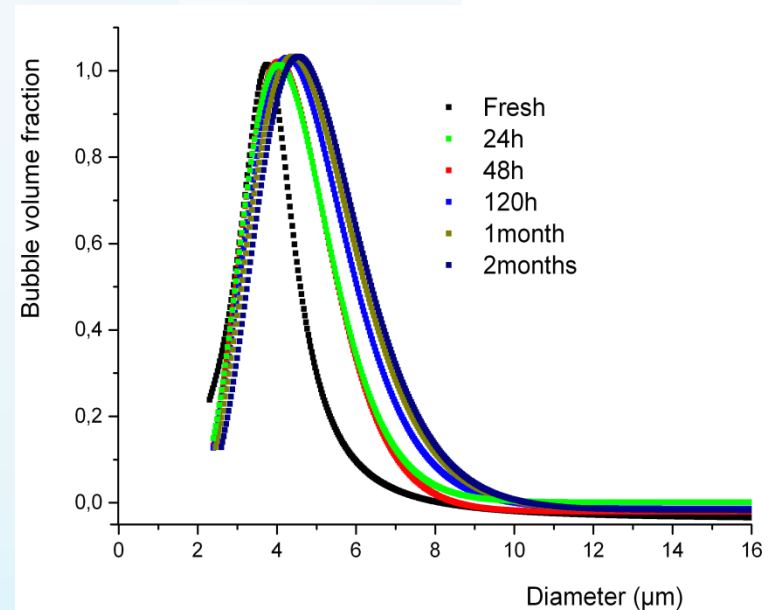
HFBII Stabilizes Fluorinated Gas μ Bubbles



Mean diameter $4 \pm 0.5 \mu\text{m}$



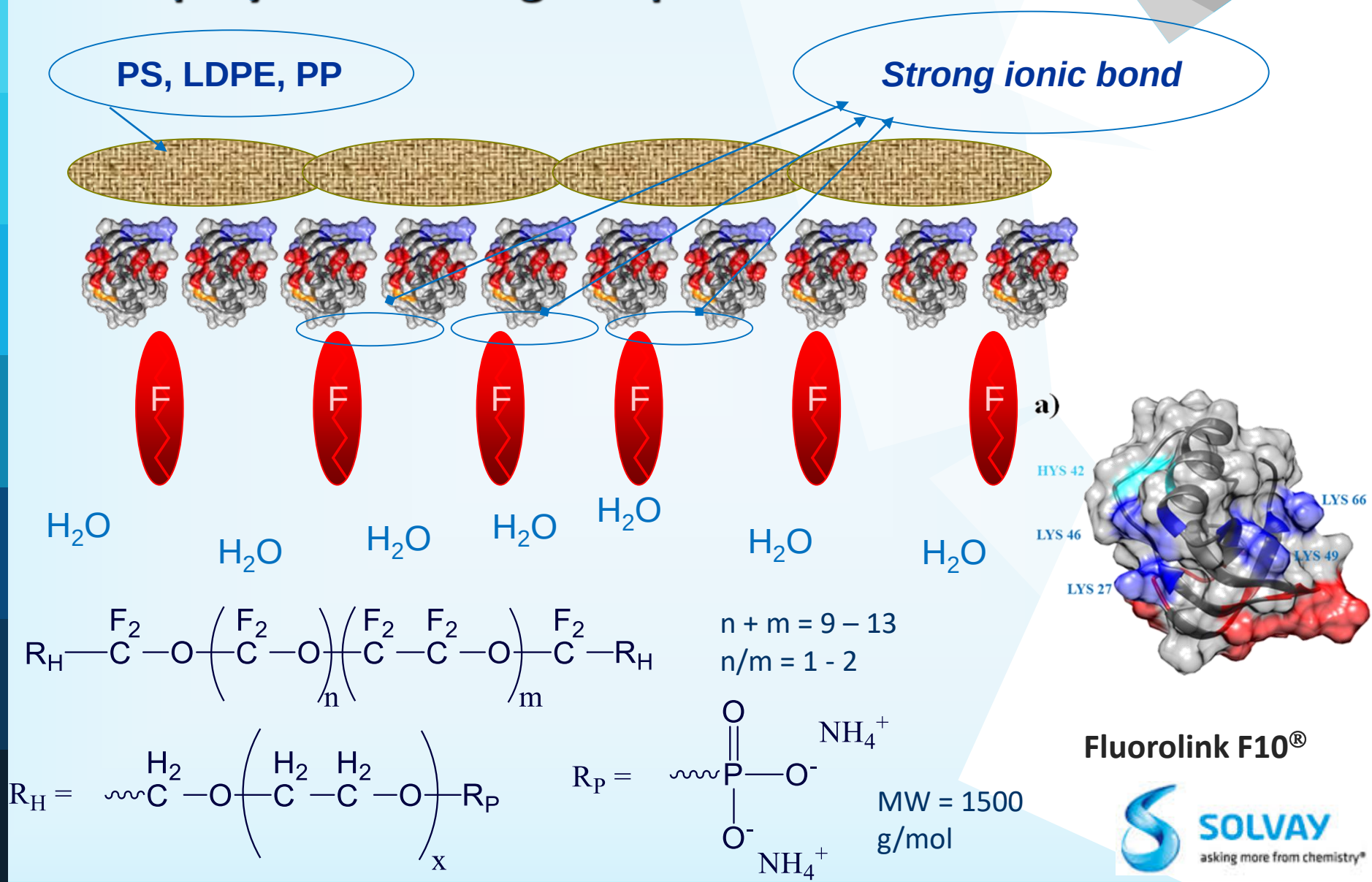
98% of the objects are spherical microbubbles



More than 2 month stability at r.t.!

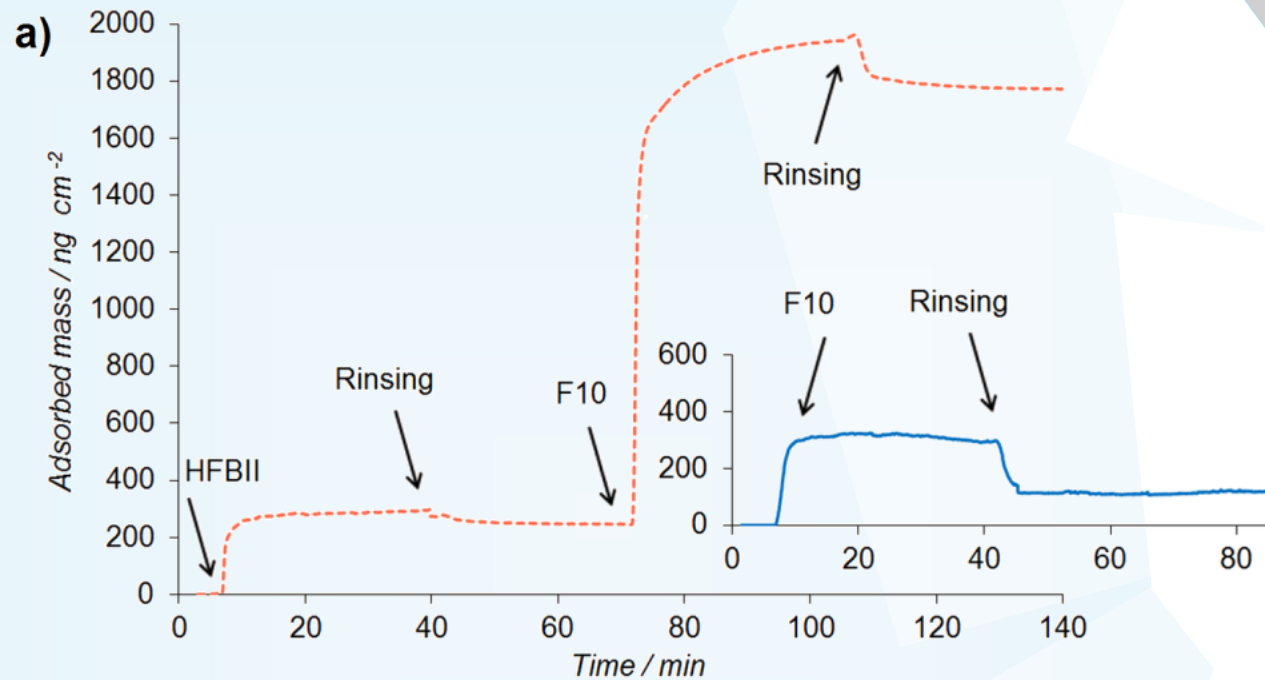
HFB as Nanosized Primer for the Fluoropolymer Coating of Apolar Surfaces

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QCM-D Binding Studies

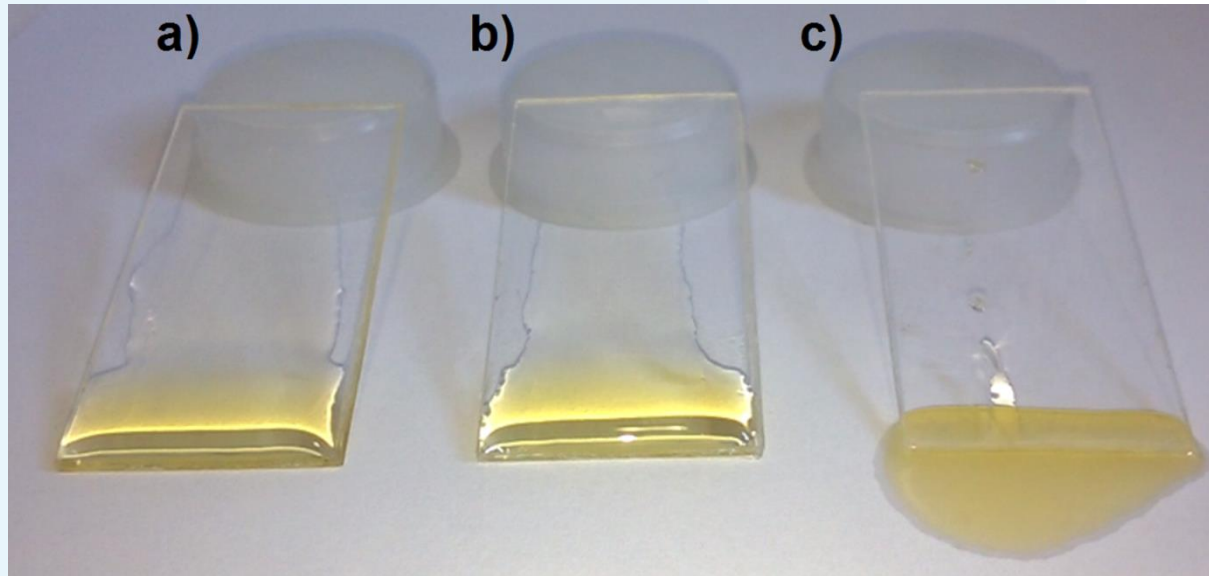
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pH	HFBII before rinsing [ng cm ⁻²]	HFBII after rinsing [ng cm ⁻²]	Adsorbed mass loss upon rinsing	HFBII+F10 before rinsing [ng cm ⁻²]	HFBII+F10 after rinsing [ng cm ⁻²]	Adsorbed mass loss upon rinsing
3	246	206	17%	937	920	2%
	-	-	-	267	102	62%
4	291	246	16%	1940	1772	9%
	-	-	-	320	118	63%
5	277	247	11%	550	426	23%
	-	-	-	83	55	34%
6	271	243	11%	330	285	14%
	-	-	-	68	46	33%
8	249	217	13%	243	220	10%
	-	-	-	58	31	49%

Oleophobicity of the HFB-F10 Bionanocomposite Film

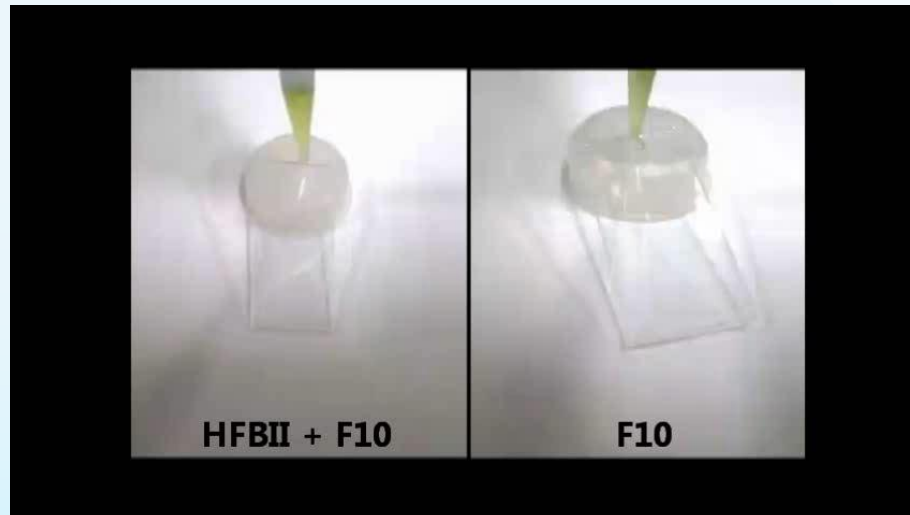
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PS

PS + F10

PS + HFBII + F10



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