Tuning the surface properties of hybrid organic-inorganic nanoparticles

Bilateral Workshop
Nanotechnology and Nanoapplication

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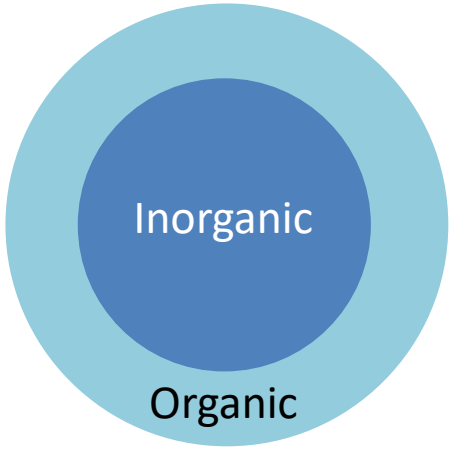
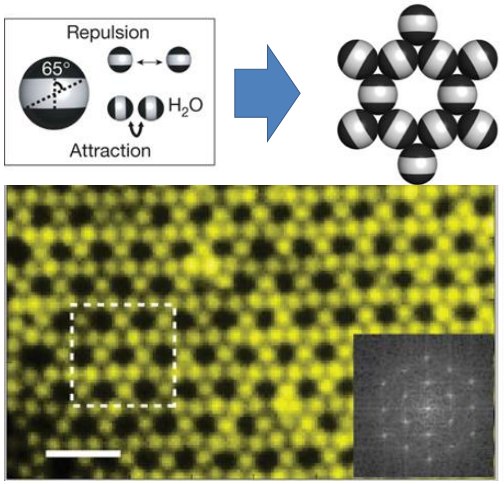
Paolo Pengo
University of Trieste

The surface properties of hybrid organic-inorganic nanoparticles



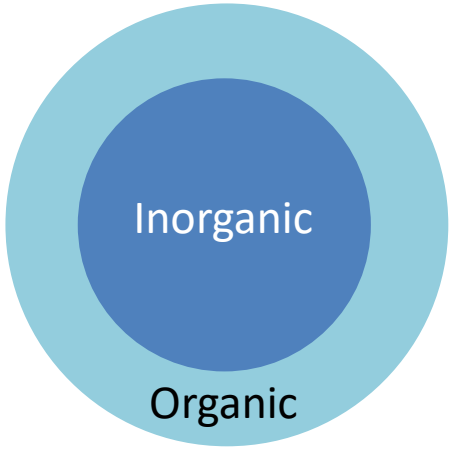
Surface Anisotropy

- Solubility and stability in solution
- Recognition of small molecules
- Adhesion to nano and mesostructures
- Self-assembly



Nature **2011**, 469, 381–384

The surface properties of hybrid organic-inorganic nanoparticles



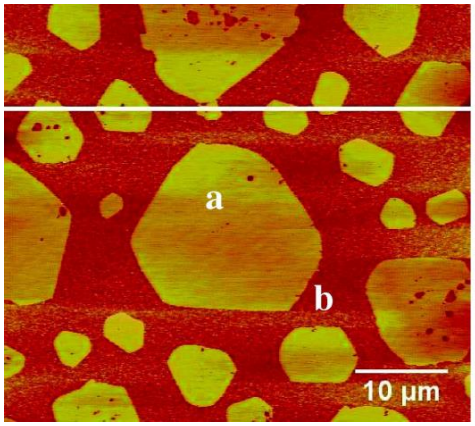
Surface Anisotropy

- Solubility and stability in solution
- Recognition of small molecules
- Adhesion to nano and mesostructures
- Self-assembly

Bulk

Chem. Soc. Rev., **2012**,*41*, 31-42

Meso-scale

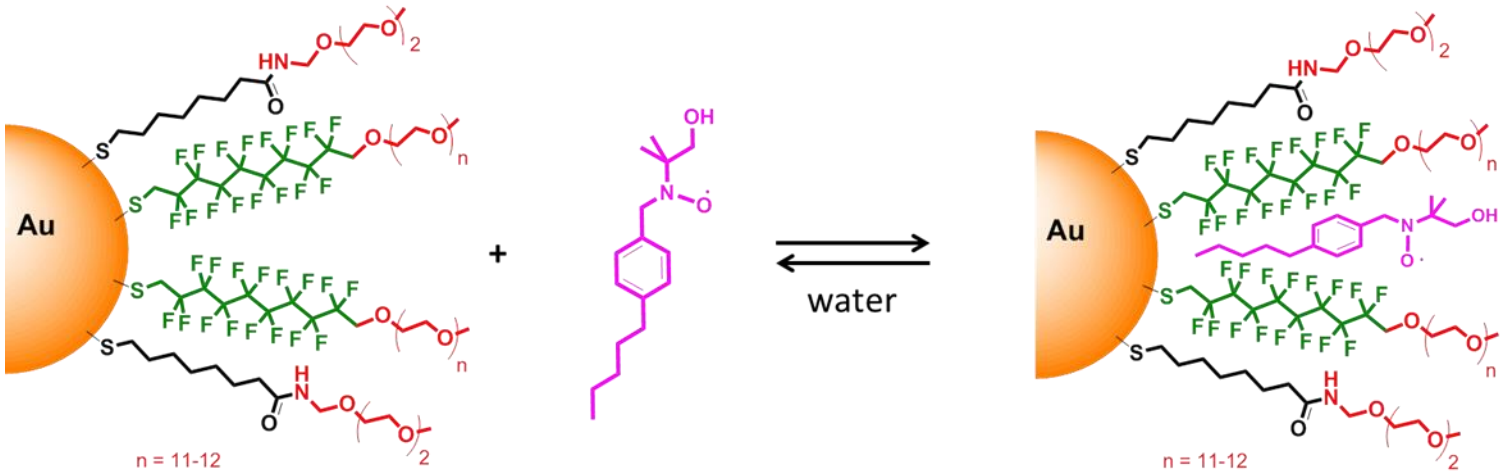


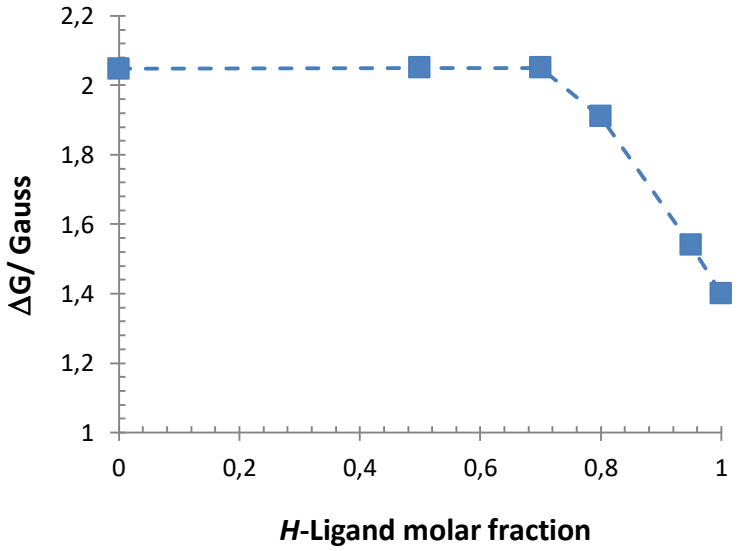
J. Colloid Interface Sci **2012**, *380*, 105–112

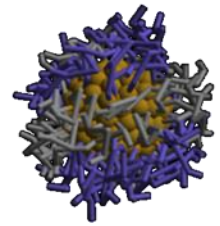
Nano-scale

?

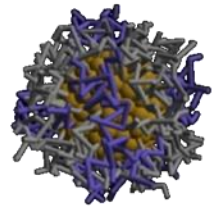
ESR highlights discrete patches on the surface of mixed-monolayer gold nanoparticles



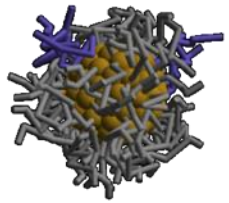




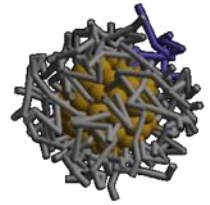
X_H = 0.50, ∅ 2.2 nm



X_H = 0.71, ∅ 2.5 nm



X_H = 0.80, ∅ 1.9 nm

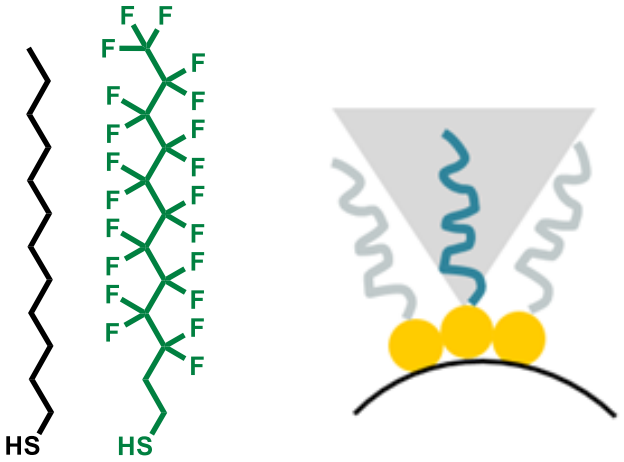


X_H = 0.95, ∅ 1.9 nm

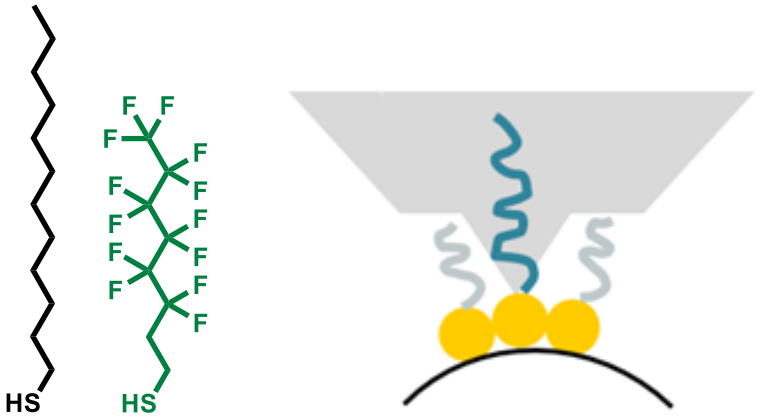
Angew. Chem. Int. Ed. **2009**,*48*, 3060 –3064

ACS Nano **2012**, *6*, 7243-7253

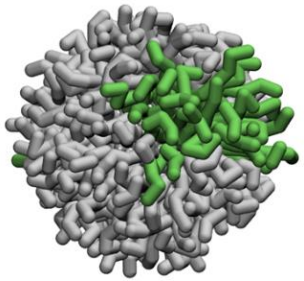
Can we predict a monolayer morphology on a design basis? A matter of entropy-enthalpy balance and ligands structure



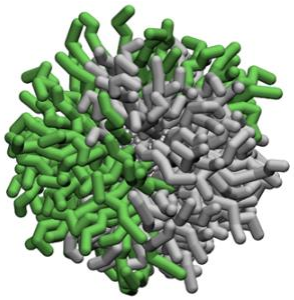
Low conformational entropy



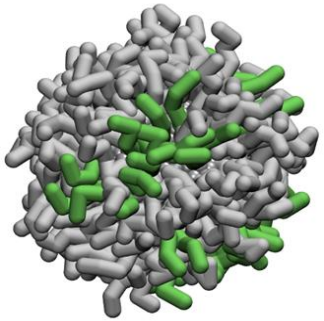
High conformational entropy



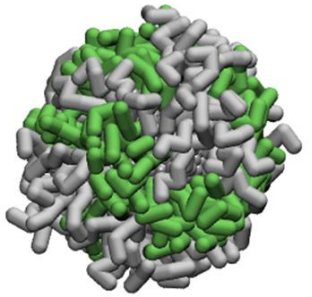
$Au_{1289}C12_{194}F10_{31}$
13.9 % **F10**



$Au_{1289}C12_{133}F10_{88}$
36.6 % **F10**



$Au_{1289}C12_{185}F6_{46}$
20% **F6**

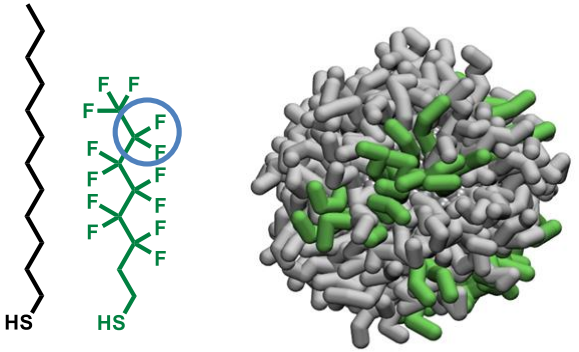


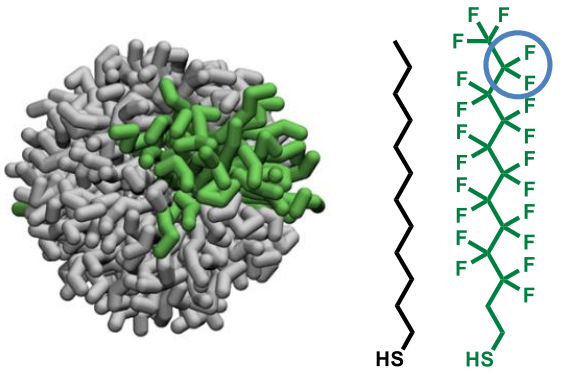
$Au_{1289}C12_{123}F6_{112}$
47.8% **F6**

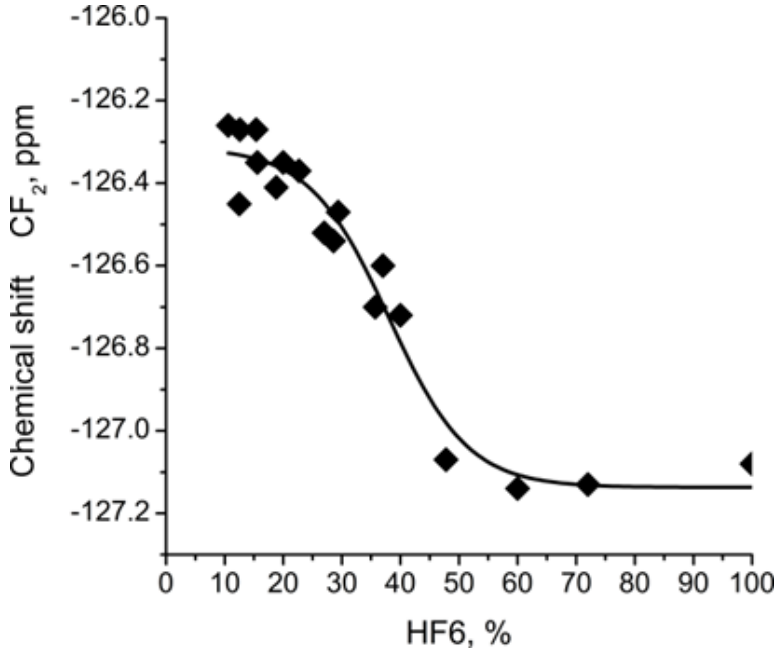
ACS Nano, **2016**, *10*, 9316–9325

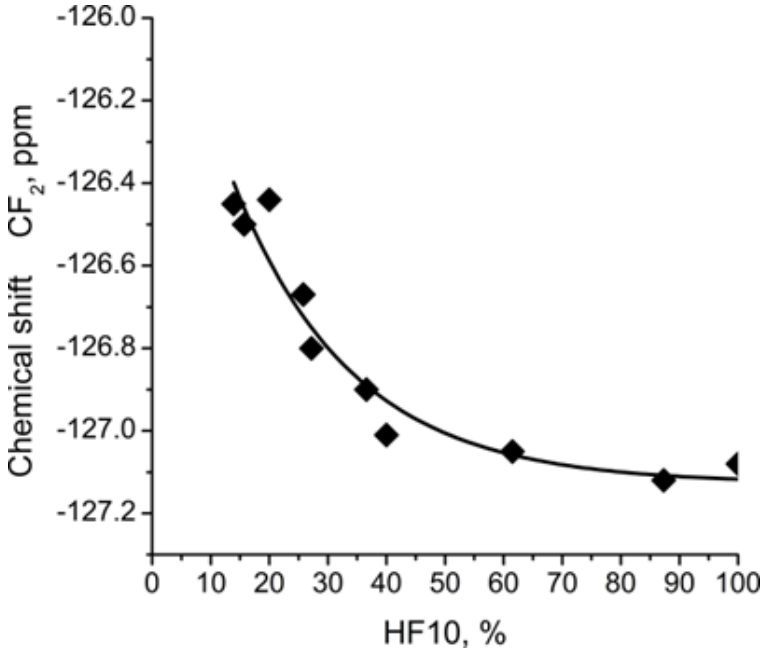
Different morphologies have specific spectroscopic signatures

^{19}F NMR analyses



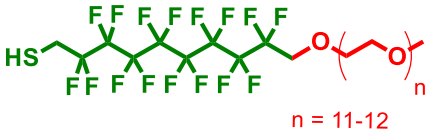


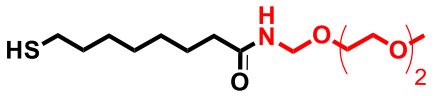




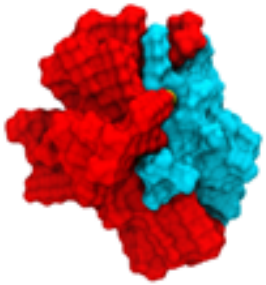
ACS Nano, **2016**, *10*, 9316–9325

‘monolayer isomers’ have different interaction properties with phospholipid membranes





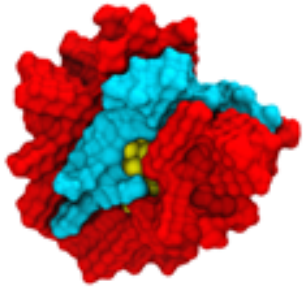
Janus



$Au_{140}H_{24}F_{32}$ D = 1.6 nm

K_D = 330 ± 50 μM

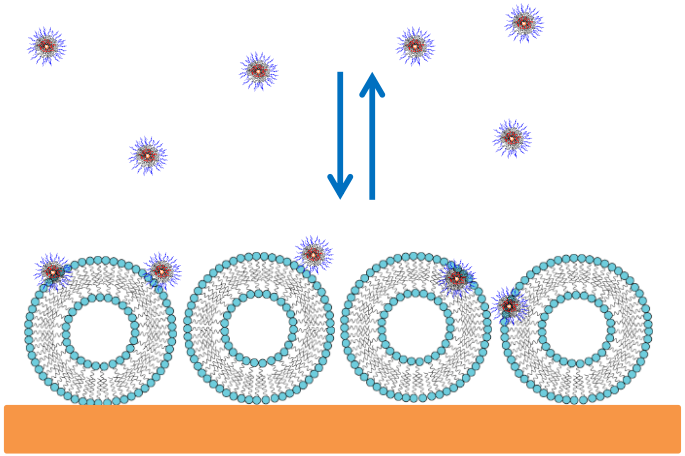
Stripe-like

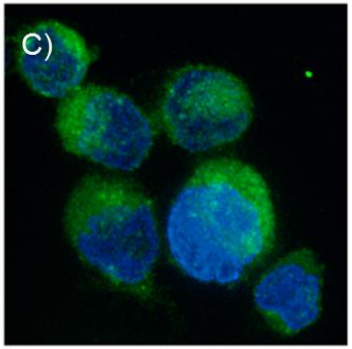


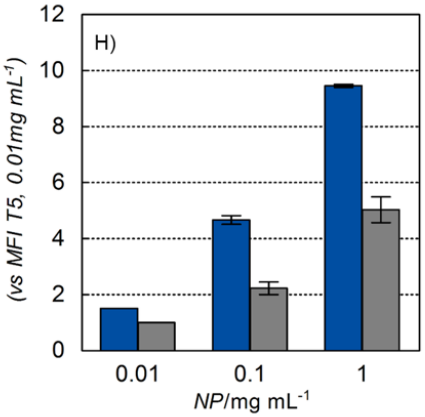
$Au_{260}H_{20}F_{36}$ D = 1.9 nm

K_D = 80 ± 30 μM

Probing nanoparticles-membrane interaction *via* SPR







Morphology	ΔG adh [Kcal/mol]	N° contacts	Contacts	
			Hydrophylic [%]	Hydrophobic [%]
Janus	**-28.6 ± 1.5**	21 ± 2	59	41
Stripe-like	**-38.9 ± 1.0**	25 ± 1	63	37

Small **2019**, *15*, 1900323

Conclusions and Perspectives

Different monolayer morphologies are predictable because encoded in the structures of the passivating ligands

Different monolayer morphologies are addressable by spectroscopic techniques

Tuning the monolayer morphology allows endowing particles with different interaction properties

We are interested in exploiting these materials in the biomedical field and material sciences

Acknowledgments

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