

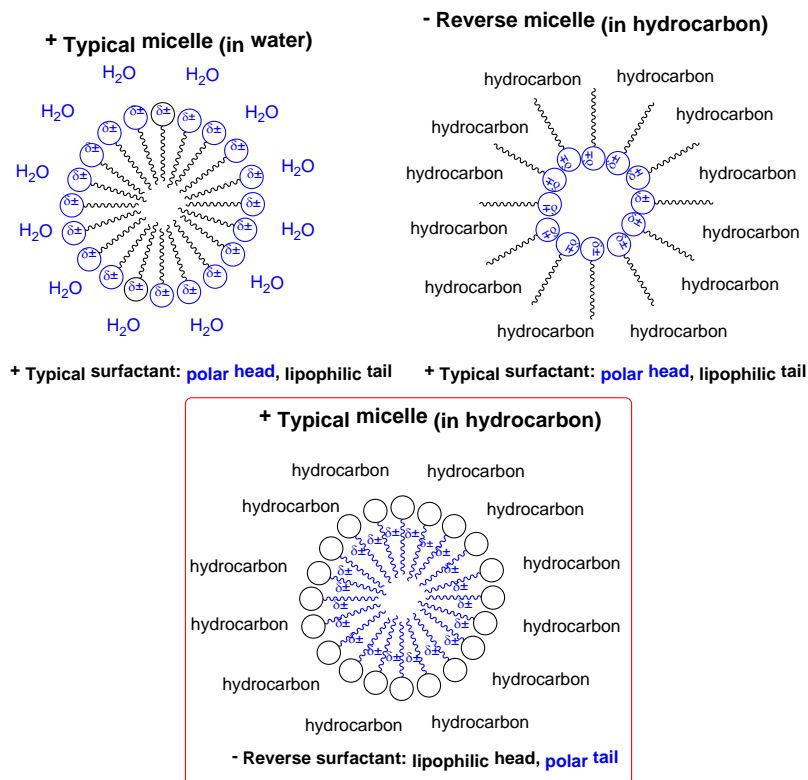
# Life in hydrocarbons: typical micelles from reverse amphiphiles in hexane

Manuela Facchin<sup>1</sup>, Alvise Perosa,<sup>1</sup> Piero Riello<sup>1</sup>

We show experimental evidence of supramolecular aggregates of reverse surfactants in hydrocarbon solvents. In our view, this represents the first example of self-assembled “typical” (as opposed to “reverse”) micellar structures in a non-aqueous environment.

Our research follows speculations on the existence of life forms outside Earth, such as for example exotic metabolic chemistry in Titan’s liquid hydrocarbon lakes. Two different types of mechanism for organism formation in the methane lakes of Titan were envisaged. The first is Earth-like: compartmentalization – a key requirement for life – might be achieved in liquid methane by self-assembly of conventional surfactant molecules (*e.g.* phosphatidylcholine) to form reverse liposomes in a hydrocarbon medium.[1] The second alternative implies completely reversing the paradigm of life-as-we-know-it-on-Earth in order to adapt it to the hydrocarbon solvent. This second option is at the basis, for example, of theoretical studies conducted by simulating membrane structures dubbed “azotosomes”, based on nitrogen containing reverse surfactant molecules.[2]

With the aim of determining the viability of the latter “reverse paradigm” experimentally, we synthesized two different “reverse” surfactants – *i.e.* bearing a polar hydrophilic tail and a lipophilic head – and we attempted to observe which kind of molecular assemblies they would form in hydrocarbon solvents.



a.

b.

c.

Figure a. Typical aqueous micelle.

Figure b. Reverse micelle.

Figure c. Expected micelle formed by a reverse surfactant in hydrocarbon solvent

Our experimental structural data based on SAXS show that our reverse surfactants form organized molecular aggregates in hexane. In particular, one of the reverse surfactants formed typical micellar structures with a 20 Å

<sup>1</sup> Dipartimento di Scienze Molecolari e Nanosistemi, Centre for Sustainable Chemical Technologies, Università Ca' Foscari Venezia, Dorsoduro 2137, 30123 Venezia, Italy

radius, presumably with the lipophilic heads of the surfactant facing outwards towards the hydrocarbon solvent and the polar tails condensed in the nucleus. We were also able to calculate its critical micelle concentration in hexane. The second surfactant, with a larger critical packing parameter, showed the formation of other types of structured aggregates, currently being investigated. Based on these data, we think that the concept could be extended and that other surfactants could form bilayers and vesicles, providing the foundation for membrane mimics in hydrocarbons.

- [1] L. H. Norman, A. D. Fortes, *Astron. Geophys.* **2011**, *52*, 1.39-1.42  
[2] J. Stevenson, J. Lunine, P. Clancy, *Sci. Adv.* **2015**, *1*, e1400067