Contribution ID: **106** Type: **Invited speaker**

SAXS/SANS and contrast matching: a unique key to highlight the structure-property relationships for petroleum industry related systems

Friday, 20 May 2022 09:30 (30 minutes)

Knowing the refined structure of complex crude oils and the mechanisms of actions of these structures is of a central interest to understand and predict the behaviors of the petroleum fluids for many industrial applications: oil production, transportation and refining, enhanced oil recovery or gas sequestration. Crude oils are well known to be complex mixtures made of many different constituents. Among them, Asphaltenes are the enigmatic fraction of petroleum that can act as natural surfactants to stabilize water-in-oil emulsions, foams, to interact with flat surfaces or porous media and finally to drive the macroscopic properties of the fluids (viscosity, flow behavior, phase separation, affinity for interfaces etc…). Since twenty years, it has been demonstrated with pioneers works of Espinat [1] that small angle scattering techniques, namely SAXS and SANS, are very powerful to identify supramolecular structure of the Asphaltenes entities. Starting from that, we developed fifteen years ago a long term fruitful collaboration between IFPEN and LLB and ILL with Isabelle to address these critical questions by focusing on the use of specific neutron contrast variations on multi-components petroleum systems while associating SANS and SAXS. During the workshop, we will present three dedicated relevant examples of such unique approach (i) the characterization of the interfacial Asphaltenes layer in water-in-oil emulsions in line with the emulsion macroscopic stability [2] (ii) the first quantitative modeling of the Asphaltenes nano-aggregates [3] and (iii) a new methodology to probe in-situ the foam flow in porous media [4-5].

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Session Classification: Talks