Effects of ultrasound on colloidal organization at nanometer length scale during cross-flow ultrafiltration probed by *in-situ* SAXS

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Effects of ultrasound (US) on the structural organization within concentrated particles layer during cross-flow ultrafiltration of colloidal dispersions have been characterized for the first time by *in-situ* time-resolved small-angle X-ray scattering (SAXS). A novel ‘‘SAXS Cross-Flow US-coupled Filtration Cell’’ has been developed to, on one hand, apply ultrasonic waves close to the flat membrane by embedding in the feed compartment a thin titanium vibrating blade connected to a 20 kHz ultrasonic generator and on the other hand, to monitor *in-situ* the colloidal organization of the concentrated layer by SAXS [1]. Thanks to this cell, concentration profiles and structural organization (orientation, aggregation/disaggregation) have been measured as a function of the distance z from the membrane surface with 20 µm accuracy and linked to the permeate flux, cross-flow and transmembrane pressure registered simultaneously [2]. Several aqueous colloidal clay dispersions have been studied: i) synthetic disk-like Laponite clay (1 nm x 30 nm) ii) natural plate-like Wyoming Na-montmorillonite [3] (1 nm in thickness, 100 nm in lateral averaged size).

In-situ ultrasonication leads to a significant increase of permeate flux [4] by a factor 3 to 5 arising from several mechanisms depending on the nature of the electrostatic particle interactions (attractive or repulsive), the shear induced orientation phenomena and the structural organization near the sol-gel transition of the dispersions. The competition between US, compression forces and inter-particle interactions has led to different changes in the structural organization near the membrane surface: i) progressive disruption during time of the concentrated particles layers in the case of the dominant attractive interacting Laponite particles [1] or ii) not any disaggregation of the accumulated layers with a probably shear-localization or localized particle agitation phenomena in the case of dominant repulsive interacting Wyoming Na-montmorillonite particles. Similar structural phenomena have been revealed for other colloidal dispersions as casein micelles, starch and cellulose nanocrystals.

References

[1] - Jin Y. *et al.*, J. Memb. Sci. under revision (2013).
[2] - Pignon F. *et al.*, Langmuir **28**, 1083-1094, (2012).
[3] - Paineau E. et al., Langmuir, **27**, 5562-5573, (2011).
[4] - Hengl N. *et al.*, Ultrason. Sonochem. doi: http://dx.doi.org/10.1016/j.ultsonch.2013.11.008 (2013).