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Micromodel porous network with heterogeneous wettability

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Micromodels are 2D transparent model porous networks allowing for observations and quantification of numerous phenomena involved in fluid flow in porous media. In the context of energy studies, such as for CO2 storage or geothermal energy, micromodels are increasingly used. At the pore scale considered (i.e., roughly 10 - 100 µm for the micromodel), effects of surface and interfacial properties are enhanced when compared to larger scales. From an experimental point of view, being able to control wettability is thus crucial to gain in representativeness of micromodels so as to better understand diphasic and multiphasic flows in porous media.

This study focuses on the development of polymer micromodels with an increase of representativity by means of a spatially heterogeneous wettability obtained from localised silica coatings. Manufacturing involves photoetching, hot embossing of a COC polymer material (Cyclic Olefin Copolymer), localised deposition of a thin layer of silica (SiO2) by plasma polymerisation of TEOS
(Tetraethyl orthosilicate) and closure of the micropattern by lamination. The surface treatment allows for a decrease in wetting angle from 87° (drop of water in air on untreated COC) to 30° (on treated COC). These steps have been optimised and the analyses show the stability of the surface treatment over several weeks. The model porous devices developed are designed for atmospheric pressure and ambient temperature working conditions. The resulting micromodels are used to show the influence of wettability heterogeneities on single and multiphase flows in a porous medium through several experiments, including the injection of a water-in-oil emulsion**.

** See also presentation "Tortuosity-governed droplet transport in a microfluidic porous network"(Elliot SPEIRS, Nicolas PANNACCI, Marie-Caroline JULLIEN, Maxime MOREAUD)

Participation

In-Person

References

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