CONTROLLED SOLVENT EXCHANGE IN A POROUS MATERIAL: EXPERIMENT & THEORY

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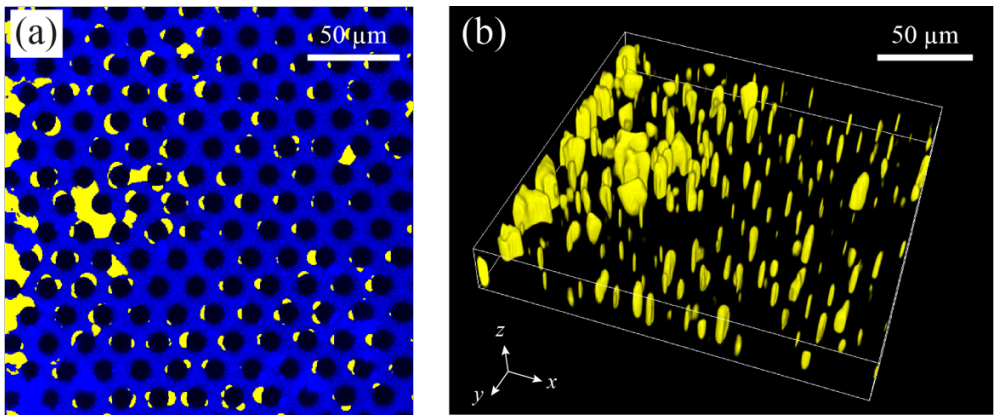
Abstract: Solvent exchange is a bottom up method to generate micro/nano droplets by nucleation & growth out of an oversaturated solution. In solvent exchange, an oversaturation pulse of a dissolved component, typically an oil, is generated during the mixing of its two miscible solvents, where the good solvent for oil is displaced by the poor one. Here we analytically and experimentally study the solvent exchange in a Hele-Shaw cell type channel with a quasi-2D porous region in the middle. For all the porosities tested, it is found that all of the oversaturation of oil nucleates into droplets and get trapped by the porous region, so that the mixture is no longer oversaturated at the end of the porous region. Solvent exchange is performed with various solvent compositions and flow rates, and the measured total volume of oil is found to depend on the Péclet number *Pe* with a power law exponent about 0.51. To explain this, we develop a theoretical model based on the ternary phase diagram, where the analytical solution of the total volume of oil is obtained by integrating the composition distribution of oil oversaturation. The total volume of oil is found to increase with Péclet number *Pe* as $\propto Pe^{1/2}$, where the prefactor can be calculated from the solvent composition. Moreover, we studied how the flow resistance induced by the oil droplets vary with flow rate. These findings may help to improve our understanding and guide further design of solvent exchange.



Confocal images of oil droplets (yellow) in the porous material (black) after solvent exchange (blue is water).

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