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A universal surface modification approach to functionalize microchip devices with rocks/soils surface chemistry

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The surface chemistry discrepancy between microchips and real rocks/soils restricts the full application of microfluidics technology to subsurface energy and environmental research. Here, we creatively rebuild rock/soil surface chemistries in microchips by forming mineral coatings with an advanced coating technique - layer-by-layer (LbL) assembly technology.[1] The outcome of this work is a series of 'surface-mimetic micro-reservoirs (SMMR)', which represent multi-types and multi-scales of rocks/soils with corresponding rock surface chemistry (e.g., chemical compositions, wettability and surface roughness). Microchip devices made of polydimethylsiloxane (PDMS), glass, Poly(methyl methacrylate) (PMMA) and Norland Optical Adhesive (NOA) are employed for the surface modification and the subsequent surface characterizations and two-phase flow experiments. The morphological and structural properties of the formed mineral coatings are characterized by Scanning Electron Microscopy (SEM), optical microscopy and profilometer; the coating stability is tested by flooding experiments; the surface wettability and roughness are also characterized by measuring mineral oil/water contact angles. The results demonstrate the formation of fabricating material–irrelevant, nano to micro scale, fully-covered and stable mineral surfaces in microchips. In addition, two-phase flow experiments are conducted in the developed SMMR to demonstrate one application of studying the fluid dynamics in subsurface porous media. This work opens horizons for the full applications of microfluidics technology on subsurface energy and environmental research.

References

[1] Y. Q. Zhang, A. Sanati-Nezhad and S. H. Hejazi, Lab on a Chip, 2017, DOI: 10.1039/C7LC00675F.

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