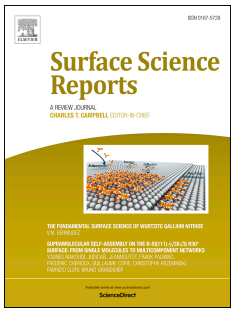
Accepted Manuscript



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PII: S0167-5729(18)30001-3

DOI: 10.1016/j.surfrep.2018.01.001

Reference: SUSREP 456

To appear in: *Surface Science Reports*

Received Date: 3 November 2017

Revised Date: 28 December 2017

Accepted Date: 29 December 2017

Please cite this article as: H. Tian, M. Wang, Electrokinetic mechanism of wettability alternation at oil-water-rock interface, *Surface Science Reports* (2018), doi: 10.1016/j.surfrep.2018.01.001.

Electrokinetic mechanism of wettability alternation at oil-water-rock interface

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Abstract: Design of ions for injection water may change the wettability of oil-brine-rock (OBR) system, which has very important applications in enhanced oil recovery. Though ion-tuned wettability has been verified by various experiments, the mechanism is still not clear. In this review paper, we first present a comprehensive summarization of possible wettability alteration mechanisms, including fines migration or dissolution, multicomponent ion-exchange (MIE), electrical double layer (EDL) interaction between rock and oil, and repulsive hydration force. To clarify the key mechanism, we introduce a complete frame of theories to calculate attribution of EDL repulsion to wettability alteration by assuming constant binding forces (no MIE) and rigid smooth surface (no fines migration or dissolution). The frame consists of three parts: the classical Gouy-Chapman model coupled with interface charging mechanisms to describe EDL in oil-brine-rock systems, three methods with different boundary assumptions to evaluate EDL interaction energy, and the modified Young-Dupré equation to link EDL interaction energy with contact angle. The quantitative analysis for two typical oil-brine-rock systems provides two physical maps that show how the EDL interaction influences contact angle at different ionic composition. The result indicates that the contribution of EDL interaction to ion-tuned wettability for the studied system is not quite significant. The classical and advanced experimental work using microfabrication is reviewed briefly on the contribution of EDL repulsion to wettability alteration and compared with the theoretical results. It is indicated that the roughness of real rock surface may enhance EDL interaction. Finally we discuss some pending questions, perspectives and promising applications based on the mechanism.

***Keywords*:** wettability alteration; electrical double layer interaction; ion exchange; electrokinetics; liquid-solid interface

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