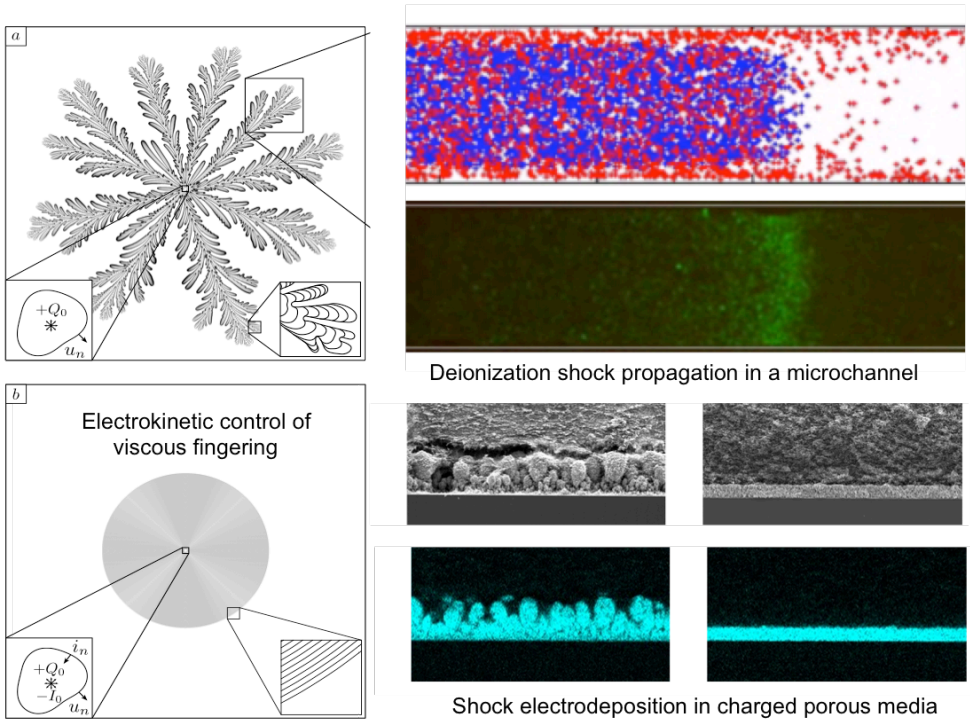
Plenary Lecture, ELKIN, Dresden, Germany, September 10, 2017

Electrokinetic Control of Interfacial Instabilities

Martin Z. Bazant
E. G. Roos (1944) Professor of Chemical Engineering and Mathematics
Executive Officer, Department of Chemical Engineering
Massachusetts Institute of Technology

Electrokinetic phenomena have been extensively studied for the past two centuries, but mainly under the assumptions of linear response and single-phase flow. Interfacial motion is a fundamental source of nonlinearity and instabilty in multi-phase flow, which has been considered in electrohydrodynamics for leaky-dielectric interfaces (e.g. Taylor cones) but mostly overlooked in electrokinetics for electrolytes in charged porous media. This lecture will describe three fundamental interfacial phenomena – viscous fingering[1], deionization shocks[2,3], and dendritic electrodeposition[3] – whose stability can be controlled by electro-osmotic flow and surface conduction, as evidenced by both theory and experiment. Possible applications include electrically enhanced oil recovery[1], water purification by shock electrodialysis[3], and metal batteries and nanofabrication enabled by shock electrodeposition[4]. These phenomena will also be related to the control of thermodynamic stability by autocatalytic reactions, with applications from batteries to biology[5].



1. M. Mirzadeh, M. Z. Bazant, arXiv:1706.04669
2. A. Mani, M. Z. Bazant, Phys Rev. E 84, 061504 (2011).
3. S. Schlumpberger, N. B. Lu, M. E. Suss, and M. Z. Bazant, Environ. Sci. Technol. Lett. 2, 367-372 (2015).
4. J.-H. Han, M. Wang, P. Bai, F. R. Brushett, and M. Z. Bazant, Scientific Reports 6, 28054 (2016).
5. M. Z. Bazant, Faraday Discussions (2017). arXiv:1704.00608