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A new effective macroscopic Stokes-Cahn-Hilliard formulation for immiscible fluids in porous structures MARKUS SCHMUCK, MARC PRADAS, Department of Chemical Engineering, Imperial College London, UK, GRIGORIOS PAVLIOTIS, Department of Mathematics, Imperial College London, UK, SERAFIM KALLIADASIS, Department of Chemical Engineering, Imperial College London, UK — Guided by thermodynamic and variational principles we describe mixtures of incompressible fluids in strongly perforated domains with a general class of phase field equations coupled to the Stokes equations. Important applications include subsurface flows, fuel cells, and microfluidics. Starting with a microscopic formulation for heterogenous domains (e.g. a porous medium), represented as the periodic covering of a single reference cell, we rigorously derive effective macroscopic phase field equations under the assumption of periodic flow for large Péclet numbers by the multiple scale method with drift and our recently introduced splitting strategy for Ginzburg-Landau/Cahn-Hilliard-type equations [1]. We recover systematically diffusion-dispersion relations (including Taylor-Aris-dispersion) as for classical convection-diffusion problems. Our results provide a convenient computational framework to macroscopically track interfaces in porous media. In view of the well-known versatility of phase field models, our study proposes a promising formulation for many engineering and scientific applications such as multiphase flows in porous media and oil recovery, for instance.

[1] Schmuck, Pradas, Pavliotis, Kalliadasis, 2012. Proc. R. Soc. A 468, 3705 (2012).

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