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Phase field formulations for reactive two-phase flow

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Two-phase flow problems and reactive flow with changing pore geometry both include a free boundary at the pore scale. Chemical reactions as mineral precipitation and dissolution can alter the pore structure; hence the fluid-grain interface evolves following the reaction rates. The presence of two immiscible fluids introduces an evolving fluid-fluid interface depending on the flow itself and surface tension. Problems with evolving boundaries are usually formulated through the location of the sharp interfaces, but we here propose phase field formulations that allow formulating the relevant processes on a larger regular domain with the evolving interface appearing as a diffuse transition of non-zero width. From a numerical point of view, the phase field formulation is simpler as the small-scale structures do not need to be explicitly resolved but is instead captured through the evolution of the phase fields. In the limit as the diffuse interface width approaches zero, the usual sharp interface formulation is obtained. Further, the pore scale phase field formulations can be upscaled to the macro (Darcy) scale using homogenization.

References

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