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Computational Homogenization Accounting for General Imperfect Interfaces

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The objective of this presentation is to establish a micro-to-macro transition framework to study the behavior of heterogeneous materials whereby the influence of the interface at the micro-scale is taken into account. Due to increasing area-to-volume ratio with decreasing size, the interface assumes a more pronounced effect on the material response at small scales. Hence, it is of crucial importance to account for interfaces at the micro-scale. Including interfaces at the micro-scale introduces a length-scale into the first-order computational homogenization. The interface-enhanced computational homogenization framework captures a size effect in the material response that is missing in the classical computational homogenization [1].

The interface model in this contribution is general imperfect. Within the continuum mechanics setting, interface behavior is often described using the cohesive zone model or interface elasticity theory. The cohesive zone model allows for the jump in the deformation field across the interface but, restricts the traction jump to vanish. On the contrary, the interface elasticity theory permits the traction jump across the interface, however, it is only valid for coherent interfaces and thus, no displacement jump at the interface is allowed. A class of general imperfect interface model is proposed in this presentation and it is shown that both cohesive zone model and interface elasticity theory can be derived as two limit cases of this general model [2]. Furthermore, computational aspects of general imperfect interfaces using the finite element method are detailed. A consistent computational homogenization scheme accounting for general imperfect interfaces is established. Suitable boundary conditions to guarantee meaningful averages and bridging between the scales are derived. Finally, the proposed theory is elucidated via a series of numerical examples.

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