Isogeometric cut-cell methods for the discretization of higher-order imperfect interface models for thin layers and elastic material surfaces

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ABSTRACT

Thin interphase layers are ubiquitous in problems that involve the coupling of different physical systems across their contact surface. Typically, the characteristic length scales of the interphase layer and the global system are separated by multiple orders of magnitudes. Direct numerical simulation of these thin layers would require extremely aggressive refinement and is thus prohibitively expensive. Instead, we often make use of asymptotic models in which the physical behavior of the interphase is reformulated as a set of transmission conditions. In this talk, we focus on the thin layers or coatings involved in the mechanical bonding of solid materials (which are relevant in the mechanical behavior of, e.g., fibre-reinforced polymers, welded structures, concrete and various other granular materials). The asymptotic zero thickness models that we consider are those proposed by Gurtin & Murdoch [1], Steigmann & Ogden [2], and Benveniste & Miloh [3]. These models dictate discontinuous solution field, and pose jump conditions that involve higher-order differential operators. Our framework synergistically combines recent developments in cut-cell finite element methods and isogeometric analysis to naturally accommodate these two challenges: upon discretization with smooth splines, arbitrary order derivatives can be consistently evaluated, while cut-cell meshes enable discontinuous solutions at potentially complex interfaces. In this isogeometric cut-cell setting, we propose two different finite element formulations to tackle the interphase problem and we demonstrate higher-order accuracy in the bulk and at the interface for a number of test cases.

REFERENCES

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