## IsoGeometric LaTIn method for non-conformal coupling with non-linear interface behaviour

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## ABSTRACT

With the development of volume imaging techniques, mechanical models of a material at the microstructure scale can be created from 3D images of a sample. However, the computation of the image-based models still seems unattainable for real mechanical applications due to massive data and complex constitutive behaviours. The aim of this work is to develop an efficient numerical approach for the simulation of solids with multiple non-linear, non-conformal interfaces. Of special interest are fiber-reinforced composite materials, where local models of fibers are coupled with the global matrix model.

Immersed boundary methods are used in the framework of IsoGeometric Analysis (IGA) to tackle the complex geometry of multi-phase objects, resulting in improved per-degree-of-freedom accuracy by using spline basis functions and alleviating meshing process. Since the non-linearities are located at the interfaces, we aim to take advantage of the Large Time Increment (LaTIn) method [3]. Here, the LaTIn method separates the non-linear local and the global linear equations and applies an iterative scheme between both. LaTIn-based solvers have been applied, for instance, with a FE immersed approach (CutFEM), to model multiple contacts [2]. The present work extends the LaTIn to higher-order immersed IGA. The non-conformal coupling is treated by Nitsche's approach, which has shown optimal convergence behaviour, particularly for global/local analysis [1].

In the proposed method, inspired by [4], two conformal layers are built on the matrix/fibre interface, thus separating the difficulties regarding non-linearity and non-conformity. The LaTIn method is used to couple the layers, incorporating the non-linear behaviour, and Nitsche's method is then used to couple the layers with the geometrically simple, non-conformal matrix or fibre models. The method has been tested through multiple numerical examples, including unilateral and friction contacts, and examples with cohesive interfaces will also be presented.

## REFERENCES

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