Multiscale Finite Element Method for the Eddy Current Problem in Iron Laminates

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The overall dimensions of a transformer core, for instance the length, etc. on the one hand and the thickness of the laminates etc. on the other hand yield an extremely large ratio between the macro-scale and the micro-scale, up to 10^6. The discretization of each laminate by finite elements (FEs) would lead to large systems of equations, whose solution is faraway from being a routine task for modern computer power. The laminated iron core represents roughly a periodic micro-structure. The multiscale finite element method (MSFEM) is introduced to cope with this challenge. How to create a multiscale formulation by means of a reference solution for the magnetic vector potential $\mathbf{A}$ is discussed in detail. The performance of MSFEM is studied by various simulations of small and simple numerical examples considering the influence of averaging of the coefficients, p-refinement of the micro-shape functions and that of the standard FE polynomial bases. Particular attention is also paid to the edge effect.
In the second part of the talk a benchmark problem will be introduced which is being established in a joint work. The benchmark represents a simple single-phase transformer providing measurement data particularly interesting for simulations in the context of laminated iron cores. The benchmark shall promote the development of homogenization and multiscale methods.

Keywords: Benchmark problem, multiscale finite element method MSFEM.