Talk

Free Material Optimization of Piezoelectric Material

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Abstract

Topology optimization by the ersatz material model has been successfully applied to piezoelectric problems. The idea of the *ersatz material* model is to locally vary the underlying material tensors (stiffness, piezoelectric coupling and permittivity) by a scalar value, the *pseudo density*, in order to improve the performance of the piezoelectric component.

Here we generalize the problem to *free material optimization*, introduced for elastic material in [1], hence the full elasticity, permittivity and coupling tensor is subject to optimization. As standard piezoelectric material is transversal-isotropic (orthotropic in two dimensions) in the elasticity tensor, orthotropic in the permittivity tensor and has half the components equal to zero in the piezoelectric coupling tensor, an interesting questions is, if these properties also appear as the result of a free material optimization. Preliminary results show that this is indeed the case.

The free material optimization results will serve as a lower bound for a *local optimal polarization angle* problem of standard piezoelectric material where the transversal-isotropic stiffness, piezoelectric coupling and permittivity tensors depend on local angles which are piecewise constant within a suitable finite element discretization. A similar optimization has been performed by a stochastic approach in [2], where a significant improvement against uniform aligned material is reported.

References

[1] Jochem Zowe, M. Kočvara, and Martin P. Bendsøe. Free material optimization via mathematical programming. *Mathematical programming*, 79(1):445–466, 1997.

[2] KP Jayachandran, JM Guedes, and HC Rodrigues. Optimal configuration of microstructure in ferroelectric materials by stochastic optimization. *Journal of Applied Physics*, 108(2):024101–024101, 2010.