Support-Q Optimisation of a Trapped Mode Beam Resonator

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Abstract

The introduction of a disorder into a periodic oscillatory system induces the phenomenon of Anderson localisation. In a finite system this is exhibited by the introduction of a 'trapped mode': a mode in which the displacement field is localised to the region of the disorder (figure 1). Sensitivity of MEMS resonant sensors is dependent on a high quality (Q) factor. A main inhibitor to achieving High-Q is energy radiation through the support to the substrate: the support loss. The trapped modes exhibited by an 'Anderson localised' beam present a way to tune the support loss to a minimal value, thus are a good potential candidate for a high-Q geometry. An initial beam geometry is proposed and contrasted to a lumped-parameter model. The simplified analysis is used to gain insight into the basic parameters of interest and the underlying physics. The geometry is then optimised using parametric sweeps in COMSOL Multiphysics® software using the Structural Mechanics Module, via Eigenfrequency analysis. Separate two-dimensional resonator and substrate models are used in combination to determine an optimal geometry for a maximum support Q factor (Qs). The Qs-optimised geometry is presented and shown to be capable of achieving a value on the order of the highest currently available in the literature for mechanical resonators. The Qs value is then combined with calculated values for the other main forms of loss to obtain a theoretical maximum overall quality factor for this geometry. Its suitability for use as a high-Q resonator is evaluated against other current and proposed geometries extant in the literature.

Figures used in the abstract

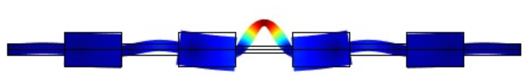

Figure 1: 'Trapped mode' of a 4.5 period Anderson localised beam.