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Thermoelastic Relaxation in Thin Plates with Applications to MEMS and NEMS Oscillators

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Equations governing thermoelastic loss in vibrating thin plates are derived. For flexural vibration a critical plate thickness exists, defining two distinct types of response, thermally thick and thin. Thermal diffusion is restricted to a 1-dimensional heat flux across the plate thickness in thick plates. Otherwise in-plane thermal diffusion cannot be ignored, and may in fact dominate. Among results obtained for thermally thick plates, it is shown that the local thermal relaxation loss depends upon the local state of vibrating flexure, e.g. thermal loss vanishes at points where the principal curvatures are equal and opposite, i.e. saddle shaped deformation. An effective plate equation is derived that incorporates the thermoelastic loss as a damping term. The general form of the effective damping can be generalized to arbitrary thickness, in particular the case of thermally thin plates can be considered. These results are useful in predicting mode widths in MEMS and NEMS oscillators.

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