Application of Raman spectroscopy on reliability prediction of Si and 3C-SiC MEMS

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ABSTRACT

The aim of this research is to develop the application of Raman spectroscopy for general reliability prediction of Si and SiC MEMS devices via either direct measurement of strain/stress or material properties recognition. Both static and dynamic Raman spectroscopy is used together with conventional optical characterisation methods. Firstly the capabilities and the limitations of Raman spectroscopy in Si and 3C-SiC MEMS device characterisation is considered. Then, using Weibull weakest link failure theory, a general reliability prediction method of such devices is developed. Single crystal Si and 3C-SiC cantilever beams actuated in their resonance frequencies will be investigated to validate the method. The methodology uses both finite element modelling and fracture strength experimental data generated from four-point bending tests to develop a series of Weibull parameters for particular materials and surface conditions. Using those parameters, a reliability prediction of a particular MEMS device will be generated on ANSYS by considering its properties and geometry. Experimental validation of the failure probability prediction under realistically dynamic multiaxial loadings of the MEMS will be performed utilising both modulated and continuous Raman spectroscopy.