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Micromechanical Fracture Strength of Semi-Insulating GaAs

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The fracture strengths of micromechanical beams of nondoped semi-insulating GaAs were measured. The maximum and average strengths are 5.0 and 2.7 GPa, respectively, with a standard deviation of ±1.4 GPa. These strength values are about half of those of similar silicon beams, but several times higher than those of high-strength steel used in construction. The strength is sufficient for applications of GaAs in piezoelectrically activated resonators or resonant sensors. The actual strength test was carried out by a simple bending test *in situ* in the specimen chamber of an SEM, and the strength was evaluated both analytically and by using FEA. It was also shown that the observed fracture limit is consistent with the assumption that fracture is initiated by As precipitates which are always present in a semi-insulating GaAs wafer. This indicates that reduction in size or finer dispersion of these precipitates might result in a stronger material.

1. Introduction

GaAs is rarely used as a material for mechanical applications, although it possesses the advantages of being semiconducting, optoelectronic, and piezoelectrically active. One of the main reasons seems to be general skepticism concerning its mechanical strength. In the form of wafers, the material is definitely more fragile than silicon, and silicon is known to be an extremely strong material on a micromechanical level.[1] The purpose of this study is to investigate whether GaAs possesses sufficient strength for micromechanical applications.

Piezoelectrically activated resonating structures for sensor and resonator applications of GaAs have been proposed in a recent study.[2] Unlike other piezoelectric materials such