Proceedings of the 9th Biennial ASME Conference on Engineering Systems Design and Analysis
ESDA2008
July 7-9, 2008, Haifa, Israel

ESDA2008-59455

Health Monitoring of Adhesive Joints using Magnetostrictive Fillers

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One major application for smart materials is measuring stresses or strains in load bearing structures. The ability to monitor structural health, and observe real time stress levels in load bearing platforms is a field of great interest. In this work, we develop and characterize a method for stress monitoring adhesively bonded joints by incorporating a magnetostrictive filler into the polymeric matrix. Magnetostrictive materials create a change in their surrounding magnetic field when subjected to strain, and thus serve as natural strain sensors, that require neither power supply nor any kind of wiring.
A clear correlation between the stress and the magnetic field, which is measured at a distance of 20-60 mm from the specimen, is observed under both shear and compression loads. Moreover, there is a significant stress region in which the relationship between the stress and the magnetic field is approximately linear. This behavior demonstrates the possibility of monitoring the average stress in a specimen by a single magnetic sensor mounted at a distance from the specimen. Additionally, complete three dimensional mapping of the magnetic field around loaded specimens reveals that the specimen magnetization is not uniform and implies the existence of a correlation between the specimen magnetization and the stress field which was numerically computed. This behavior indicates the potential of mapping the local stress profile within a specimen by using an array of several magnetic sensors. The effects of magnetostrictive particle size and of applying a magnetic field during specimen polymerization are also discussed.