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Deformation analysis techniques applied to microstructures and micro-device

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Summary

The mechanical behaviors of microstructures and micro devices have drawn the attention from researchers on materials and mechanics recently. To understand the rule of these behaviors, the deformation measurement techniques with micro/nanometer sensitivity and spatial resolution are required. In this report, a geometric phase analysis technique, SEM scanning moirAC method, digital phase moirAC method based on gratings and a micro-marker identification method are introduced to meet the deformation evaluation requirement of MEMS. The geometric phase analysis technique is performed on the basis of regular gratings, instead of natural atom lattice. The regular gratings with a pitch of range from micrometer to nanometer will be directly fabricated on the measured surface of MEMS devices by using a Focus Ion Beam (FIB). Phase information can be obtained from Bragg filtered images after Fast Fourier Transform (FFT) and Inverse Fast Fourier Transform (IFFT) of SEM scanning images. And then in-plane displacements field and local strain field related to the phase information will be evaluated. In SEM scanning moirAC method, SEM scanning lines is selected as reference grating. The moirAC fringe is formed by the superimposition of the SEM scanning lines and the specimen grating fabricated by FIB. The digital phase moirAC method is performed by the superimposition of the SEM images of specimen gratings and the digital reference grating designed. Four steps phase shifting technique is used to provide a high sensitivity for deformation measurement. Gaussian blur algorithm will be applied to getting rid of the details of both the specimen and reference gratings in resulting digital moirAC. A micro-marker identification method is also developed to measure microstructure deformation. The micro-markers were directly produced on the top surface of microstructures by taking advantage of ion milling of FIB system. Based on the analysis of marker images captured by electronic microscope with specific correlation software, the deformation information in microstructures can be easily obtained. Obtained results of validation tests show that these techniques above can be well applied to the deformation measurement with micro/nanometer sensitivity and stiction force estimation of a MEMS device.