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Designing and Analyzing Sensor and Actuator of a Nano/Micro-System for Fatigue and Fracture Characterization of Nanomaterials

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Abstract : This paper presents a MEMS/NEMS device for fatigue and fracture characterization of nanomaterials. This device can apply static loads, cyclic loads, and their combinations in nanomechanical experiments. It is based on the electromagnetic force induced between paired parallel wires carrying electrical currents. Using this concept, the actuator and sensor parts of the device were designed and analyzed while considering the practical limitations. Since the PWCC device only uses two wires for actuation part and sensing part, its fabrication process is extremely easier than the available MEMS/NEMS devices. The total gain and phase shift of the MEMS/NEMS device were calculated and investigated. Furthermore, the maximum gain and sensitivity of the MEMS/NEMS device were studied to demonstrate the capability and usability of the device for wide range of nanomaterials samples. This device can be readily integrated into SEM/TEM instruments to provide real time study of the mechanical behaviors of nanomaterials as well as their fatigue and fracture properties, softening or hardening behaviors, and initiation and propagation of nanocracks.

Keywords : sensors and actuators, MEMS/NEMS devices, fatigue and fracture nanomechanical testing device, static and cyclic nanomechanical testing device
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