Faculty of Electrical Engineering & Computer Science
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Micromechanical Functional Elements on Flexible Substrates – Fundamental and Application of Laser-based Manufacturing.

ABSTRACT - Masterthesis

Silicon has been a primary material for fabrication of microelectromechanical systems (MEMS) for several decades. However MEMS devices on flexible substrate are important for non-planar and non-rigid surface application. To support the rapid advancements of non-silicon MEMS it is necessary to introduce innovative techniques to process different MEMS material. Number of techniques for polymer based microactuation have been demonstrated in recent years. One promising microactuation technique is based on the bimetallic effect which relies an the thermal coefficient of expansion mismatch between two components of sandwiched layer to provide displacement with change in temperature. This thesis intention is to establish a novel and cost-effective fabrication process (pulsed laser machining) to eliminate polymer processing limitations arise in conventional photolithography based microfabrication techniques to produce bimetallic cantilever system.

For fulfilment of the task, the relations between laser ablation parameters and ablation performance such as the ablation rate and surface quality were obtained. Pulsed laser (nanosecond, picosecond and femtosecond laser) ablation of four different polymers (PI, PE, PET and PP) were studied in order to determine the suitable material and favourable laser source for laser micromachining. DC magnetron sputtering system was used for deposition of thin metal film on chosen polymer substrate. Process parameters were optimized to achieve low stress aluminium and molybdenum (or nickel) thin films in order to produce bimetallic system.

Free moving bimetallic cantilever microactuators were patterned. The tip deflection was measured with change in temperature and system was verified by comparison with finite element analysis. Surface profile, morphology and functional characteristics of the MEMS were investigated by scanning electron microscopy (SEM) and white light interference microscopy (WLIM).