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Polymer Processing at the Micro/Nanoscale

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Miniaturization methods and materials are well-developed in the integrated circuit industry. They have been used to produce micro-devices in other industries, such as camera and watch components, printer heads, automotive sensors, micro-heat exchangers, micro-pumps, micro-reactors, etc. This new field is known as 'Micro-Electro-Mechanical-Systems' (MEMS). In recent years, MEMS applications have also been extended to optical communication and biomedical fields. The former is called 'Micro-Optic-Electro-Mechanical Systems' (MOEMS), while the latter is known as 'Bio-Micro-Electro-Mechanical Systems' (BioMEMS). Potential MOEMS structures include optical switches, connectors, grids, diffraction gratings, and miniature lenses and mirrors. Major BioMEMS potential and existing products are biochips/sensors, drug delivery systems, advanced tissue scaffolds, and miniature bioreactors.

Current micro-devices are largely based on silicon (Si), owing to extensive development of micro-fabrication methods (e.g. lithography, thin film deposition, wet/dry etching) by the microelectronics industry. Unfortunately, the physical and chemical properties of Si-based materials (poor impact strength/toughness, lack of optical clarity, and poor biocompatibility) are not appropriate for many biomedical and optic devices. In contrast, polymeric materials possess a number of properties that make them attractive for MEMS and BioMEMS devices. Many polymers exhibit high toughness, optical clarity, and recyclability. Some also possess excellent biocompatibility and can provide various biofunctionalities. In this presentation, I will discuss our recent effort on developing various micro- and nanoscale processing and bonding techniques of polymers with focus on embossing/imprinting methods.