MCEN GRADUATE SEMINAR

Control of Light Matter Interactions Using Microelectromechanical Systems

Il Woong Jung
Center for Nanoscale Materials
Argonne National Laboratory
E-mail: ijung@anl.gov

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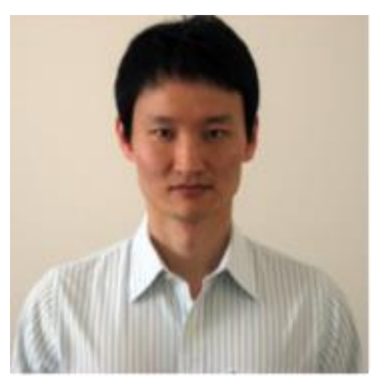
Abstract:

In this talk, I will present the current efforts at the Center for Nanoscale Materials to utilize NEMS/MEMS technology in the field of photonic sciences.

In the first part of the talk, we present our work on applying MEMS (Micro-electro-mechanical Systems) optical devices to the manipulation of synchrotron hard x-ray light sources. The high brilliance and pulsed hard x-rays from synchrotron sources make possible time-resolved studies of dynamics over a wide range of time scales, allowing relationships between structure and function to be observed. Beamlines typically use macroscopic, quasi-static optics to manipulate delivered x-ray beams. In order to take full advantage of the coherence and timing structure of current and future storage ring sources, a new class of x-ray optics needs to be developed. I will show that silicon MEMS-based devices can preserve the spatial, temporal and spectral correlation of the x-rays and function as a dynamic pulse selector at the highest repetition-rates ever demonstrated. These devices have the potential to bring a new generation of dynamic x-ray optics that can enable novel capabilities such as μ-second spectroscopy, high rep-rate pulse selection, and possibly pulse slicing to generate short pulses.

In the second part of the talk, I will present our work on control of plasmonic interactions with MEMS. The possibility to confine light to a volume beyond the diffraction limit and the ability to manipulate and enhance localized electromagnetic fields surrounding metallic nanostructures is driving the surge of research in metallic nanostructures and plasmonics. One of the critical limitations to the development of this field is the lack of a compact, robust, repeatable approach for active control of the optical coupling between plasmonic excitations. MEMS are an ideal platform for this application because they can provide fast, stable and precise control of their geometry and arrangement in a continuous manner for a large range of distances in a scalable device. We present a chip-level MEMS tunable nanoantenna device and demonstrate repeated spectral tuning of the coupled surface plasmon resonance. This type of device has potential for applications in nanoscale lithography, field-enhanced spectroscopy, high-density optical storage, and for compact sensing as in high-sensitivity chemical and biological sensors.

Biographical Sketch



Il Woong Jung received the Ph.D. degree in electrical engineering from Stanford University, Stanford, CA in 2007. His work has been on spatial light modulators for photonic applications such as adaptive optics, telecommunications, and maskless lithography. He is currently an Assistant Scientist in the Center for Nanoscale Materials at Argonne National Laboratory. His current research interests are in the manipulation of light-matter interaction at the nanoscale, specifically using micro- and nano-mechanical devices to control the optical properties of nanostructures.