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Optical MEMS and Nanophotonics

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We are investigating the properties of micro/nano-opto-mechanical systems and subwavelength optical devices for next-generation photonics technologies. The high-index contrast and small feature sizes afforded by new precision patterning and etching technologies in semiconductors and low-loss dielectric materials enable the creation of new nanoscale optical devices. Optical interferometric techniques are emerging as simple, yet exquisitively sensitive methods to read-out MEMS sensors and actuators, while micromechanical and nanomechanical displacement is proving to be an ideal method to achieve large phase or amplitude changes for integrated optical systems.

We are taking advantage of these properties to develop revolutionary new photonics technologies, all based on optical characteristics that are impossible to achieve in macroscopic systems. Our fundamental investigations of topics such as nanoslot waveguiding, coupled opto-mechanical oscillation, and photothermal spectroscopy are investigated with an eye towards Navy applications in areas such as microwave photonics, chemical sensors, and free-space optical communication.

Some specific areas of research are:

- **Semiconductor Modulators**: This research area focuses on the use of advanced quantum wells and nanofabrication for next-generation semiconductor electro-absorption and electro-optic modulators.
- **Suspended Waveguides**: Suspended semiconductor waveguides are characterized by strong confinement with low loss and offer exciting new ways to take advantage of the nonlinear, electro-optic, and polaritonic properties of III-V materials.
- **Silicon Nitride Waveguides**: We are investigating the large evanescent fields and low loss of silicon nitride waveguides for chemical sensing, microwave photonics, and cavity optomechanics.
- **Micro-opto-mechanical Sensors**: We are investigating optical interferometric and spectroscopic techniques to interrogate microbridges and microcantilevers that have been coated with functionalized materials.
- **Silicon Photonics**: Silicon waveguides form the basis of our research efforts in areas such as Fabry-Perot filters, cavity opto-mechanics, integrated optical phased arrays, and much more.