Ethan Keeler: Electrical & Computer Engineering
Mentor: Wataru Nakagawa, David Dickensheets -- Electrical & Computer Engineering
Near-Infrared Polarization Optics using Nanostructured Silicon

Silicon structures with sub-micron size features can have interesting optical properties, and have been explored in a number of application areas. In addition, these silicon nanostructures can be fabricated using standard materials and processes adapted from the semiconductor industry, streamlining their construction and enabling eventual integration with other silicon-based devices such as micro-electro-mechanical systems (MEMS) or electronic circuitry. The goal of this work is to investigate an optical device realized using a silicon nanostructure: a polarizing beam splitter (PBS), a device that reflects one linear polarization state while transmitting the other. This device consists of a grating in a silicon substrate with a thin layer of gold atop its peaks and inside its troughs. In order to evaluate the optical characteristics of this device in detail, several simpler but related devices, such as subwavelength-period gold gratings (wire-grid polarizers) and silicon gratings (form-birefrignent structures), are also investigated. We present the design, fabrication, and preliminary characterization of this family of devices fabricated in our laboratory. In creating all of these devices, the project successfully demonstrated that an optical PBS can be realized using engineered silicon nanostructures. It also quantitatively compared the new PBS device to well known structures of the same nature, and it provided an excellent side-by-side comparison of the different structures used to achieve polarization selectivity. As this work suggests, silicon is an excellent material for creating optical nanostructures, but also potentially enables large-scale integration of electrical and optical systems, which will have boundless possibilities as technology progresses into the future.