CIAN Integrated Optics for Undergraduate Native Americans (IOU-NA)

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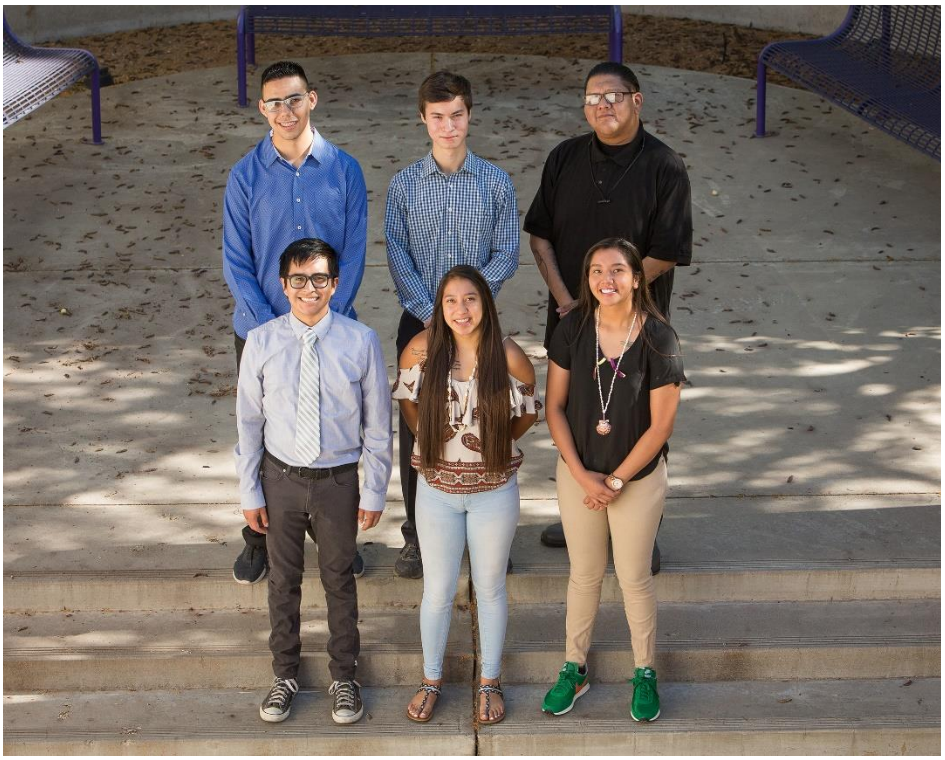

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Mario Aguilla
Preparation of Fibers for a Novel High Finesse Optomechanical Sensor
Tohono O'odham Community College, Life Science
Mentor: Dr. Felipe Guzman and Logan Richardson – Optical Sciences

Abstract

The goal of this project is to develop novel optomechanical inertial sensors. This technology consists of monolithic mechanical oscillators that incorporate highly sensitive fiber micro-optic displacement sensors that measure the motion of the oscillator's test mass. To this end, it is necessary to prepare optical fibers which will be used in the construction of high finesse micrometric Fabry-Perot interferometers.

The optomechanical inertial sensor is a compact device that is used to measure accelerations with exquisite sensitivities. The sensor consists of a test mass supported by two flexures which act as springs that allow the test mass to oscillate. We can measure the displacement of the test mass, using a Fabry-Perot optical cavity, formed between the test mass and the fiber tip used to couple light into the sensor. By coating the fiber tip, we can create a higher finesse cavity which will increase sensitivity to test mass displacement and acceleration.

During this project, I have prepared a set of fibers by removing the protective cladding, exposing the fiber tip and using a Fujikura CT-30 High Precision Cleaver to create a flat surface. I ensured a precise cleave by using a Fujikura FSM-50S Arc Fusion Splicer, to establish the cleave had angle of $< 0.3°$. These fiber-optic devices are now ready to be coated with dialectric stacks in order to realize highly reflective micro-mirrors with a surface diameter of 125 µm. Upon completion of the coating runs, the project will be ready to advance to the stage of assembling the micro-optical cavities, paving the way to conducting precision experimental investigations on their performance inside a vacuum chamber.

Hector Castro
Characterizing Optical Components for Solar Energy Systems
Cochise College, Engineering
Mentor: Dr. Robert Norwood and Remington Ketchum – Optical Sciences

Abstract

While solar panels are much better at protecting the environment than fossil fuels, they are not as effective in producing energy. Concentrating sunlight onto small, high efficiency multi-junction solar cells is one way to increase the efficiency of solar panels. Micro-scale Optimized Solar-cell Arrays with Integrated Concentration (MOSAIC) is a Concentrated Photovoltaics (CPV) project that uses cylindrical lens arrays and small waveguides to concentrate sunlight onto small (< $1mm^2$) multi-junction PV cells. Characterization of the transmission efficiency of the optical components was done experimentally using a broadband light source and results were compared to ray tracing simulations. Multiple types of waveguides were tested to see how efficiently they can concentrate light. Two different geometries were tested, the horn and the wing, and two different materials were tested as well, MS1002 and TOPAS. Cylindrical lenses were also characterized to determine how much light was lost after passing through them. Both measured and simulated efficiencies showed little variation over the visible spectrum (400-800 nm). The agreement between the simulated and experimental efficiencies varied based on the waveguide design. Overall, the waveguide with the highest efficiency was the horn (MS1002) and the waveguide closest to its simulation was the horn (TOPAS).

Ariel Lamdan
Characterizing the Noise of Homodyne Detection in the use of Continuous Variable Quantum Key Distribution
University of Arizona, Optical Engineering
Mentor: Dr. Saikat Guha and Allison Rubenok – Optical Sciences

Abstract

This research seeks to characterize the excess noise present in homodyne detection for a continuous variable quantum key distribution (CV-QKD). Experimentally, this was achieved by recording the RF output of a homodyne detector on an oscilloscope. Verification that the data collected was suitable for study was achieved by measuring the common-mode rejection ratio (CMRR) before the experiment was done and after the data point was taken. The data collected was then processed by a MATLAB code which determined the mean photon number within a virtual laser pulse as well as the excess noise term. Data analysis on the noise terms collected is incomplete, but experimental results and measurements are presented.

Joel Lopez
The Variability in the Soil Properties with Depth and Location in the Biosphere 2 Tropical Rainforest
Tohono O'odham Community College, Life Science
Mentor: Dr. Katerina Dontsova – Environmental Sciences

Abstract

Abstract pending

Amanda Miguel
Handheld Probe for Smartphone-based Device to Detect Risks for Oral Cancer
Tohono O'odham Community College, Medical/Science
Mentor: Dr. Rongguang Liang and Shaobai Li – Optical Sciences

Abstract

Oral cancer is a growing health issue in low and middle income countries distinctly in South and Southeast Asia, which can be due to tobacco or alcohol use. Professor Rongguang Liang, as well as other biomedical engineering researchers, developed an inexpensive cancer screening handheld probe for a smartphone-based device to help detect cancerous and precancerous wounds in the oral cavity. Auto-fluorescence imaging and white light imaging on the smartphone and probe are assembled together for an easy and flexible use for both the patient and doctor. Data is uploaded to the cloud where a diagnosis from a doctor will be shared with the patient. Image equality, lens magnification, and field of view performance are tested every day to improve the smartphone-based device for the best possible results.

Michael Snow
Reconfigurable Silicon Nanobeam Metasurface for Beam Steering
University of Arizona, Optical Sciences and Engineering
Mentor: Dr. Linran Fan – Optical Sciences

Abstract

Tunable metasurfaces have recently gained increased research interest as their compact planar nature makes them useful for space-efficient beam-steering applications. Metasurfaces in this research project are designed such that they are comprised of a periodic array of silicon nanobeams which deflect incident light via the effects of diffraction. These metasurfaces are designed with the goal of allowing the positions of the nanobeams to be controlled via piezoelectric forces in order to tune the behavior of the transmitted light. Simulations of several iterations of these metasurfaces are run in order to design

	these structures, and it was found that aside from altering the periodicity of the nanobeam array, it is not possible to continuously tune the angle by which the light is deflected. However, manipulating the positions of the nanobeams within each period alters the diffraction efficiencies, meaning that the light can only be deflected by certain angles which are defined by the period of the nanobeam array. These findings bring about possibilities for beamsplitters and optical switches which allow for active control of the deflection of light.
	**Tommy Swimmer** Exposure Schedule for an angle-Multiplexed PQ/PMMA Holographic Medium Ft. Lewis College, Engineering/Mathematics Mentor: Dr. Pierre Blanche and Colton Bigler – Optical Sciences **Abstract** Volume holography has garnered interest for its notable angular Bragg selectivity. The significant angular selectivity shows promise in beam steering applications, such as LIDAR. Multiplexed holograms, holograms that have multiple gratings recorded within the same material volume, require high angular selectivity and diffraction efficiency to successfully steer a beam. PQ/PMMA, a volume holographic photopolymer, was manufactured on-site with the goal to characterize diffraction efficiency as a function of energy delivered to the samples. A proposed exposure schedule has been created in regards to equal diffraction efficiency readings for a multiplexed PQ/PMMA holographic recording medium. The energy delivered to the samples ranged from 600 millijoules to 100 joules. By analyzing the diffraction efficiency of different energy exposures, clear starting points are revealed when recording holograms within this material. The rates of the exposure energy delivered have also been tested and shown to have a negligible effect on the diffraction efficiency itself. Volume holographic gratings were recorded within the PQ/PMMA samples using two-beam transmission recording techniques. Diffraction efficiency was measured after samples were processed under incoherent light. This exposure schedule can provide a starting point for anyone interested in utilizing this photopolymer for holography.