Research Plan

Designing and Optimizing a More Efficient and Inexpensive Optical Component for Thermal Cameras

Thermal cameras, also referred to as thermal imagers, use microbolometers which are an uncooled thermal sensor used to detect infrared radiation. The thermal cameras, however, can become very expensive primarily due to the microbolometers' price ($8,000 to $20,000). Typical microbolometers are made up of amorphous silicon, which is a 3D structure, meaning that the length is >100 nm in each dimension. However, 2D objects, which have lengths of >100 nm in two dimensions and a length of <100 nm in one dimension, can be more efficient in detecting infrared. The purpose of this project is to design and optimize a smaller and more efficient 2D optical component for a thermal imager. Criteria for this project include being able to successfully transmit light in the infrared spectrum (8-14 μm) and to use 2D layers. The constraint in this project includes the inability to physically fabricate the optical component, as there is no access to laboratories in the current pandemic. A possible solution is to use 2D materials that are capable of emitting light in the infrared spectrum such as graphene and hexagonal boron nitride. They are used to design nanostructures such as ribbons, disks, or any other arrangements in a periodic fashion for the optical component. The method to design the optical component is to use Lumerical, a photonic simulation software. The simulation is set up with some constants such as the spectrum of light (for example 3-18 μm), the direction of this light source, the substrate (light absorber), a transmission monitor, and a reflection monitor. Next, the 2D layers are changed into different geometries, positions, and materials to find the optimal infrared absorption of the substrate. Since there is already a constant transmission and reflectivity monitor, the only other optical property that is monitored is absorption. Thus, the values of absorption are outputted by the software. All of the mentioned methods are done by the student, meanwhile, the mentor guides and explains the meaning of values, objects, and data analysis techniques. The simulation will be optimized until desired results are achieved. In order to determine that the results are efficient, they will be compared with results obtained from literature review. To determine if the optical component is cost effective, the prices of materials used will be compared to current microbolometer material prices. A cheaper, more efficient, and smaller optical component for a thermal imager brings down the cost and increases the efficiency of the thermal imager. If the thermal imager becomes inexpensive and more efficient, then it can be used in many professional applications such as space, military, or emergency situations.