Optimization of Infrared Sensing Microbolometers

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Microbolometers have been commonly utilized in thermal imaging for surveillance, threat detection, target recognition, security, automobile, medical diagnostics, firefighting, and many other applications. Vanadium Oxide (VOx) and amorphous Silicon (a:Si) are the most prominently used infrared sensitive materials in the microbolometer industry. The goal of this research is to develop an infrared sensitive material using a combination of silicon, germanium, and oxygen ($Si_xGe_yO_{1-x-y}$) that has a more optimal performance, quantified by the material's temperature coefficient of resistance (TCR) and resistivity. We are looking for a higher TCR value with low resistivity and low noise so that the material can be CMOS compatible. We have deposited different quantities of $Si_xGe_yO_{1-x-y}$ onto oxidized silicon wafers using an RF magnetron sputtering system from two independent Si and Ge targets in an Ar/O_2 environment and tested the TCR, resistivity, and noise of samples of each wafer. Material gradients are created depending on the distance between the wafer and the sputtering target. The composition of each sample was tested using Energy Dispersive X-ray Spectroscopy (EDS) to determine the most optimal chemical composition. We then patterned metasurface, which is a hexagonal close-packed lattice structure of aluminum discs with specific diameter and periodicity, onto the samples and observed how this affected the TCR and resistivity measurements. The results showed an increase in TCR as high as 60% after the addition of the metasurface with an 86% decrease in resistivity. This suggests that certain $Si_xGe_yO_{1-x-y}$ combinations could be an excellent addition to VOx and a:Si in thermal imaging and could improve performance of thermal imaging cameras.