Title:

Narrowband Absorption Infrared Devices: Design, Fabrication, and Sensing Applications

Abstract:

In recent decades, near infrared and mid-infrared sensors have been extensively researched and applied to various fields as the most representative among them. Chalcogenide glass and pyroelectric polymer are the most widely used and most reliable materials. They have wide windows in the near-infrared and mid-infrared, which allows them to be used for mid-infrared sensing, imaging, and even storage. This graduation thesis will specifically explain how to apply and integrate the above-mentioned materials.

Chalcogenide glass, as an inorganic infrared transparent material, can be shaped by doping or etching due to its chemical properties. One of the most interesting is that under the irradiation of UV light, silver ions can directly enter the chalcogenide glass to form new compounds. Compared with the traditional doping mode, optical doping omits the necessary conditions for high temperature and saves time and cost. If patterned silver is doped into the chalcogenide glass and then subjected to an etching process, a patterned device can be obtained. In this way, chalcogenides can be directly made into infrared photonic crystals, which can modulate infrared light with specific wavelengths. This article will describe the manufacturing process of this method and the chalcogenide-based infrared photonic crystal device in detail.

If a layer of metal is deposited on the surface as a cladding layer of the chalcogenide infrared photonic crystal, the infrared transparent device will be converted into an infrared light absorbing device. After light energy is converted into heat energy, the corresponding electrical signal can be obtained through the further conversion of pyroelectric materials. This is the working principle of most infrared sensors. Compared with the working mode of traditional thermocouples, pyroelectric materials only respond to changes in temperature, which means that even if the absolute value of the temperature is high, there will be no signal generation if the temperature cannot change over time. This characteristic of responding only to temperature changes makes it more widely used.

Similarly, pyroelectric materials as high polymers can also be directly used as mid-infrared organic sensors due to their chemical properties. Their specific absorption of mid-infrared can directly convert light energy into electrical signals. Due to this characteristic, the pyroelectric polymer can be perfectly combined with the transistor, especially the graphene transistor. The liquid phase pyroelectric polymer can be spin-coated on the surface of the graphene, and the graphene can be fixed after curing. After metal deposition and other steps, a graphene transistor is formed on the surface of the pyroelectric polymer. Such a highly integrated device will have a good sensing effect in the infrared band.