Development of GRadient Refractive INdex (GRIN) optics by ionic exchange for thermal imaging applications in the 8-12μm range

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Abstract

Thermal imaging is based on the principle of detecting electromagnetic radiation emitted by hot bodies. Therefore, thermal cameras allow us to detect the temperature of bodies emitting heat. The access to this information is essential in many fields related to defense, security, public health or energy. In order to facilitate and democratize the use of such cameras, it becomes necessary to answer the SWaP-C challenge (Size, Weight, Power and Cost) by optimizing the size, weight, optical power and cost of these optical systems. In order to address this issue, the work of this thesis focused on the development of GRadient of Refractive INdex (GRIN) optics in chalcogenide glasses by ionic exchange. Ionic exchange is a well-known and industrialized process for the creation of GRIN optics in oxide glasses, but only few tests have been performed in infrared transparent glasses. We have therefore sought to develop and optimize Na+/K+ and Na+/Ag+ ion exchange processes in nitrate baths on (0.72 GeSe2 - 0.28 Ga2Se3)75 (NaI)25 chalcogenide-halide glass composition, and attempt to understand their limitations. We also studied the optical properties and the shaping of these glasses before and after ion exchange. These studies have led to the realization of the first moldable GRIN lenses with polynomial index profiles, with index differences up to the order of 10-1. The interest of these infrared optics with refractive index gradient has been demonstrated in collaboration with ONERA and the company UMICORE IR Glass.

Keywords: Chalcogenide glasses, Optics, GRIN, Infrared, Ionic Exchange, Thermal Imaging

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