OBJECTIVE: Develop and deliver optical elements that minimize reflection and improve light transmission by the additive fabrication of nanostructured arrays. The fabrication of ANA should include growth methods for IR lensing materials including Ge, ZnS, GaAs, and CaF2.

DESCRIPTION: U.S. Army sensor systems are complex optical instrumentation with rigorous requirements related to their function and operational environments. These requirements lead to very complex optical designs, particularly for imaging systems in the inferred operating at broadbands such as 3-12 µm. For complex systems with many optical elements, it is imperative to reduce unwanted reflections and maximize transmission to the focal plane array. A promising method of reducing reflection is an array of subwavelength features on the surface of an optical element. These features effectively create a gradient refractive index reducing reflection leading to higher transmission. This method is inspired by nature and is often referred to as a “moth eye coating” and has many advantages over other means of AR coatings, including being broadband, omnidirectional, and polarization-insensitive.

The Army desires methods of creating additive nanostructured arrays on IR lensing materials. These methods should effectively grow crystals of the substrate lens material at a high aspect ratio perpendicular to the surface to create the desired anti-reflective effect. These methods can include, but are not limited to, colloidal growth and chemical vapor deposition. Proposed methods should limit lithography and etching methods.

A method is required for each of the IR lensing materials, Ge, ZnS, GaAs, and CaF2, with the resulting ANA reducing reflection to below 1% in the 3-12 µm band at incident angles of up to 60°. The method should be able to accommodate substrates from 12-155 mm in diameter and with a curvature of twice the radius. The high-rate production should not significantly increase the cost of optical elements and should be able to be applied to uncoated COTs lens. Successful ANA AR strategies will be supported and implemented through the appropriate Army Cross-Functional Teams and Program Offices. This topic would have particular benefit to the 3rd Gen FLIR Program of Record and its support to the Next Generation Combat Vehicle Cross Functional Team (NGCV CFT).

PHASE I: The proposer shall complete an exhaustive literature search and report to the Army experimental strategies for fabrication of ANA for each of the IR lensing materials. The report shall also include design parameters for the ANA that will make effective AR coatings. These conclusions should be supported by modeling efforts and peer-reviewed literature.

PHASE II: Using the results of Phase I, fabricate and deliver a flat and cured examples of all the IR lensing materials for Army evaluation. Each method of ANA manufacture should be well documented and the resulting features thoroughly characterized. Examples of each will be subject to the Army environmental and durability testing procedures.

PHASE III DUAL-USE APPLICATIONS: Transition applicable techniques and processes to a production environment with the support of an industry partner if needed. Finalize a methodology production for elements with appropriate performance metrics. Determine the
best integration path as a capability upgrade to existing or future systems. Commercially, this technology will be widely applied in devices in the telecommunications and aerospace industries.

REFERENCES:


KEYWORDS: Optics, Anti-Reflective Coating, Infrared Sensor