Name(s)
Andy Y. Zhu

Project Number
38174

Project Title
Moth Eye Anti-Reflective Coating for Near-Infrared Astronomical Applications

Abstract

Objectives/Goals
Infrared observations are some of the most important observations, allowing rare AGNs, deeply embedded stars, globular clusters, low luminosity stars, and much more to be discovered and studied. When using infrared telescopes, they must be cooled to cryogenic temperatures (<100K) in order to limit the noise generated by the telescope itself. Most importantly, the materials must be transparent. Silicon satisfies the criteria, but due to its high index of refraction (n~3.42), the surface of silicon reflects 30% of all incident light. In order to use silicon in infrared instruments, an anti-reflective coating is needed to increase transmission. Biomimicry of moth eyes yielded a new coating, capable of satisfying all the above conditions.

Methods/Materials
To properly characterize, four tests were carried out: wavefront, scattered light, incident angle dependence upon transmission and upon reflection. In these tests, the physical deformities were measured with an interferometer and the effectiveness was determined. A baseline was also established in the function of the AR coating, specifically to traditional multilayered coatings.

Results
The results demonstrated nearly perfect manufacturing of the coatings, with data comparable to that of a mirror. However, the transmission of the moth eye AR coatings at 1.55 microns was suboptimal due to improper height of the corneal nipple array. The decrease in transmission when angled was insignificant before 20 degrees. When angled, the moth eye coatings produced similar results to a double layered AR coating.

Conclusions/Discussion
Because of these results, it was determined that this new AR coating has potential to be used in space based telescopes. With this, it paves the road to miniaturization of optical systems while increasing resolving power. Though more characterization must be performed at different wavelengths and heights, moth eye AR coatings are promising in advancing infrared astronomy.

Summary Statement
I characterized a new anti-reflective coating based on the nanostructures on moth eyes that holds potential for usage in space-based telescopes.

Help Received
Dr Jian Ge at the University of Florida provided materials and guidence on how to carry out standard astronomical research. I performed all the experiments and analysis myself.