Moth-Eye Anti-Reflective Structures Using Optimized Aperture Shapes

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To improve the RF transmission performance (i.e. bandwidth and insertion loss) of moth-eye anti-reflective structures known as dielectric windows I have optimized the shape of the individual apertures that comprise the dielectric window. These anti-reflective structures are described in M.S. Mirotznik, et al, "Broadband Antireflective Properties of Inverse Motheye Surfaces", IEEE Transactions AP, Vol. 58, No. 9 September 2010. The dielectric window is designed as an appliqué or surface treatment for a structural composite. The primary objective of the dielectric window surface treatment is to create a transmission window within the structural composite to add functionality beyond mechanical and structural properties to the composite thereby creating a composite with electromagnetic capability. An electromagnetically compatible structural composite would have a major impact on current antenna design and integration paradigms used in ship building and other areas.

Using the Rigorous Coupled Wave Analysis (RCWA) technique, dielectric windows have been designed. Reflections over wide bandwidths and incident angles are nearly eliminated as referenced above. Several dielectric window structures have been designed and fabricated using both optimized and non-optimized shapes. These structures are designed to exhibit performance over various frequency bands. Currently, the principal investigator has designed dielectric windows at X and Ku-band (8-12 GHz, 12-18 GHz) frequencies. Similar to the development of Frequency Selective Surfaces, dielectric windows initially utilized very basic aperture shapes that are not optimized. The paper and presentation will compare previous work with non-optimized shapes with the latest effort which explored optimized shapes using Genetic Algorithm optimization as well as impedance tapers like the Klopfenstein taper.