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APPLIED ELECTRIC FIELD ON SMART OPTICAL MATERIAL (SOM), ALUMINUM DOPED-ZINC OXIDE (AZO), SIMULATED BY J.A. WOOLLAM'S (JAW) WVASE SOFTWARE FOR SPACE APPLICATIONS - PART I

Abstract

Smart Optical Materials (SOM) are Field-Controlled Smart Active Optics (FCSAO) that obtain a change in their optical properties by an external application of energy. The application of energy can be of different forms (i.e., electric, magnetic, stress, strain, heat, light, etc.). The Advanced Energetic Electronic Materials (AEEM) Lab group at the National Aeronautics and Space Administration (NASA) in Langley's Research Center (LaRC) in Hampton, Virginia (VA) was interested in developing multifunctional optical materials that could have a change in their optical properties upon the application of an external stimulus.

Their research on SOMs was conducted to investigate the type of materials and fabrication methods needed to obtain these types of dynamic optical materials. Their research began with Gallium Nitride / Scandium Nitride (GaN / ScN). They used a modified J.A. Woollam Variable Angle Spectroscopic Ellipsometer (VASE) to monitor the applied voltages of 0, 1000, and 1500 Volts (V) and see if the applied field would create a shift in the index of refraction (n) of a bandgap engineered sample of Scandium Gallium Nitride (ScGa-xN). They achieved a shift in the index of refraction which shows promising results for Smart Optical Materials. This applied voltage is very high and may not be feasible for space missions.

My research investigates building upon the research that was conducted in the AEEM group by researching the gradient thin film of Aluminum Doped Zinc Oxide (AZO) that is fabricated by Atomic Layer Deposition (ALD). AZO is a SOM and has promising Transparent Conducting Oxide (TCO), Meta-Material (MM), and Plasmonic Material properties that's able to shift its real and imaginary permittivity in the IR range with an applied voltage of 0-12 V. Above 12 V the AZO thin film experiences an irreversible breakdown in the thin film and ultimately the cause of this breakdown is of interest as a solution to breakdown would provide a higher dynamic multifunctional operation for space applications.

Here we investigate simulating the AZO thin film with J.A. Woollam's WVASE software to see if the issues that may cause a breakdown of the AZO thin film can be identified and then we model scenarios of improved thin film models to see if it is possible to create a more functional sample of AZO. The hope is that simulating an applied electric field monitored by VASE will assist in creating a more ideal AZO gradient thin film structure for ALD Deposition.