Optical and Thermal Characterizations of Metal-Insulating Phase Transition Titanium(III) Oxide

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Titanium(III) Oxide (Ti_2O_3) is a phase transition oxide with a metal-to-insulating temperature (MIT) near 200ºC. Optical and thermal measurements of Ti_2O_3 can benefit the design and implementation of tunable radiative emission coatings, where the compositional x in TiO_{2-x} is sought to change the MIT. We have grown TiO_{2-x} film by well-controlled molecular beam epitaxy (MBE). The MBE process provided precision control of x, while providing *in situ* Auger stoichiometry measurements. The objective of our thin film synthesis and spectrometry is to provide a broadband infrared spectrum of temperature-dependent dielectric functions of Ti_2O_3. A 700 Å TiO_{2-x} film has been grown by MBE at room temperature, with a slow controlled deposition rate being 0.32 Å per minute. The presence of a phase transition is apparent in the color with the respective change in the amount of oxygen in the film, with its blue shade indicating x near 0.25 ($Ti_2O_{3.50}$). This corresponds to the Ti_2O_3 corundum phase. We noticed depositions in 10^{-7} Torr background pressure of O_2 caused the film color to be rusty brown. Annealing in UHV created the oxygen deficiency / vacancy in the film with reappearance of blue shade and Auger estimated stoichiometry of $Ti_2O_{3.50}$. Subsequent depositions necessitate UHV anneal to achieve the stoichiometry closer to Ti_2O_3 for optically thick films >1000 Å. The optical measurements were carried out in UV/vis ellipsometry to obtain VASE models for precise thin film thickness. An FTIR with heater-controlled backside in variable reflectance configuration provided spectra between room temperature and 200ºC, normalized to a heated reference. The ongoing task of thermal and spectral characterizations can enable development of plasmonic emitters, with aptly corresponding blackbody emissions in the mid-infrared.