Nondestuctive Characterization of Thermochromic Materials for Tunable Thermal Devices

Roberto Li Voti [C, S], Grigore Leahu, M.C. Larciprete, G. Cesarini, Concita Sibilia and M. Bertolotti
Dipartimento di Scienze di Base ed Applicate all'Ingegneria, Sapienza Università di Roma, Roma, Italy
roberto.livoti@uniroma1.it

I. Fratoddi
Dipartimento di Chimica, Sapienza Università di Roma, Roma, Italy

Thermochromic materials, changing their spectral properties as a function of the temperature, are extensively studied in the search for active control of thermal emission. These are for example niobium dioxide (NbO2), vanadium sesquioxide (V2O3) and vanadium dioxide (VO2). We present here a detailed infrared study of the semiconductor-to-metal transition (SMT) in a vanadium dioxide (VO2) film deposited on silicon wafer. The VO2 phase transition is studied in the mid-infrared (MIR) region by analyzing the transmittance, reflectance and emittance measurements. The temperature behaviour of the emissivity during the SMT put into evidence the phenomenon of the anomalous absorption in VO2 which has been explained by applying the Maxwell Garnett effective medium approximation theory, together with a strong hysteresis phenomenon, both useful to design tunable thermal devices to be applied for the thermal control of spacecraft. We have also applied the photothermal radiometry in order to study the changes in the modulated emissivity induced by laser. As example we present and compare the experimental results obtained on a single layer of vanadium dioxide, and of a multilayer VO2/Cu designed so to maximize the tenability of emissivity. The experimental results show how the use of these techniques represent a good tool for a quantitative measurement of the optothermal properties of vanadium dioxide based structures. This work has been performed in the framework of a collaboration between Sapienza University of Rome and the Defence R&D Canada Valcartier research center. Part of the work has been granted by Italian Ministry of Defence.

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