PO3009

Sputter Deposition of Thin Films on Different Substrate Materials Analyzed by means of Modulated IR Radiometry

Francisco Macedo[1], Sutharat Chotikaprakhan[2], Puchong Kijamnajsuk[2], Filipe Vaz[3], Roberto Faria Junior[3], Jurgen Gibkes[4], Josef Pelzl[4], Bruno Bein[4]

[1]Universidade do Minho, Braga, Portugal [2]Department of Physics, Faculty of Science, Kasetsart University, Bangkok, Thailand [3]Physics Center, University of Minho, Campus de Gualtar, Braga, Portugal [4]Solid State Spectroscopy, Physics & Astronomy, Ruhr-University, Bochum, Germany

fmacedo@fisica.uminho.pt

While thin films of different composition (TiCO, ZrN) deposited by sputtering on substrates of stainless steel substrates [1] can be analyzed by means of Modulated IR Radiometry, using inverse solutions of the two-layer thermal wave problem [2], similar thin films on Silicon substrates exhibit additional effects, which may be related to the excitation and recombination of charge carriers at the surface of the substrate and to the semi-transparency of Si in the IR spectrum.
To analyze the effects at the interface between coating and substrate systematically, a small series of ZrN thin films has been deposited on different substrates (Stainless steel, Si, glass), with the substrate surfaces cleaned by etching under controlled conditions. For the ZrN films different deposition times have been used.
To identify and quantify the various effects, the measured modulated IR signals have been normalized using reference signals measured for the different substrate materials and for opaque homogeneous glassy carbon.
For the first quantitative interpretation the normalized IR phase lag signals have been used, which depend on a minor number of thermal coating parameters and optical parameters than the IR amplitude signals. In the measured and inverse calibrated IR phase lag signals several effects and coating properties have be identified, respectively determined: - (1) heat propagation in the substrate and heat transition at the coating-substrate interface at very low heating modulation frequencies, - (2) Thermal coating properties at intermediate heating modulation frequencies, and - (3) effects of semi-transparency, roughness, and additional surface layers of differing thermal transport properties at high heating modulation frequencies.
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Keywords
Modulated IR radiometry, sputter deposition, substrate preparation
thin films, stainless steel