

Photoinduced Ultrafast Phase Transition in VO₂ Thin Films Monitored by Time-Resolved Spectroscopic Ellipsometry

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Phase-change materials (PCM) can undergo fast and reversible changes between crystalline and amorphous phases what makes them great candidates for many reconfigurable photonic devices. A thorough understanding of processes affecting local and temporal optical constants of PCMs provides the knowledge of technological limitations of these materials and their applicability. The changes in optical and electrical properties can be induced thermally, electrically or optically. Photoexcitation by laser pulses opens the perspective of monitoring even ultrashort changes in subpicosecond timescale. Employment of broadband ultrashort laser pulses for time-resolved ellipsometry enables monitoring ultrafast temporal evolution of the complex dielectric function of the studied material [1]. Here, we present application of this technique to study the ultrafast dynamics of the photoinduced insulator-to-metal transition (IMT) in vanadium dioxide (VO₂) thin films [2]. We have identified distinct thermal and non-thermal dynamics in the photoinduced IMT, which critically depends on the exciting wavelength and fluence. Time evolution of the pseudodielectric function of the VO₂ thin film during thermally and photoinduced phase transitions reveals that the primary differences in the IMT pathways are driven by nonequilibrium dynamics during the first picosecond after the photoexcitation. These and other findings of the study underscore the utility of time-resolved pump-probe spectroscopic ellipsometry as an effective tool for investigating phase transitions in strongly correlated materials.

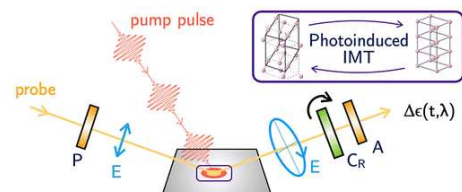


Figure 1: Pump-probe ellipsometry experiment to monitor photoinduced insulator-to-metal transition

[1] S. Richter et al. (2021), Rev. Sci. Instrum., 92, 033104.

[2] Y. Gutiérrez et al. (2024), ACS Photonics, 11, 4883-4893.

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