Thermal Conductivity Mapping of Graphitized Polydimethylsiloxane Thin Film

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Novel functional thin film materials, such as graphitized polymer thin films, have attracted considerable interest due to their potential for industrial applications including thermal driven micro actuators. However, experimental measurements of the thermal conductivity of these materials are very few and insufficient to understand the mechanism of their unique physical behavior. Thermal transport properties of these materials are very important for both understanding the mechanisms of their unique properties and for achieving optimal thermal design in their applications. In addition, these thin film materials are considered to have anisotropic thermal transport properties that differ in the in-plane and out-of-plane, which further complicates their thermal behavior. The aim of this study is to measure and map anisotropic thermal conductivity of these novel thin film materials. Here, we have proposed a 2D scanning measurement of anisotropic thermal conductivity of a graphitized Polydimethylsiloxane (PDMS) thin film fabricated by the two-photon absorption and the photothermal effect. Femtosecond laser irradiation is used to modify the surface of the PDMS thin film. To achieve highly accurate measurement in the inhomogeneous graphitized polymer film, surface profile and composition of the sample is simultaneously monitored with the 2D scanning data of thermophysical properties measurement. The frequency domain thermoreflectance (FDTR) signal is detected during the 2D scanning. In the measurement, modulated laser light is utilized to heat the sample and the reflectance change caused by the temperature-induced variations of the optical properties. The validity of anisotropic thermal conductivity measurement is also discussed through numerical simulation and preliminary measurement using a micro-fabricated membrane sample.