A Stethoscope-like 3ω Technique for On-Site Thermophysical Properties Measurement

Peng Yue
University of Chinese Academy of Sciences, Beijing, Shijingshan District, China

Lin Qiu [C], Xinghua Zheng [S] and Dawei Tang
Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, Haidian District, China
qiulin@iet.cn

The 3ω measurement method is now widely used for thermal properties characterizations. The freestanding sensor based on polyimide film expands its application to much broader field, porous material, for example. Due to the existence of the polyimide film, the signal frequency must be low enough to ensure that it can penetrate the film and finally reach the sample. Lower frequency signal means larger time constant for the lock-in amplifier, thus the whole measurement process is time-consuming. In order to fundamentally reduce this time, new basement material for the freestanding sensor must be employed to increase the detection frequency and decrease the time constant. We choose sapphire as the basement for its high thermal diffusivity (more than one hundred times larger than the polyimide film), which is essential to determine the penetration frequency. Moreover, sapphire is rigid enough (which hardness is second only to diamond in nature) to resist most damage to the nickel strip deposited on it. A series of standard samples are tested by the new sensor, and results show that the stethoscope style freestanding 3ω technique make the measurement more rapid, and the sensor itself is more durable. Benefited from the reduction of measuring time, this technique achieves on-site measurement for the 3ω method, which means that thermal properties of most types of materials can be acquired easily, and the measurement process is no longer limited in laboratory.