Optical parameter extraction and error analysis of terahertz time domain spectrum detection

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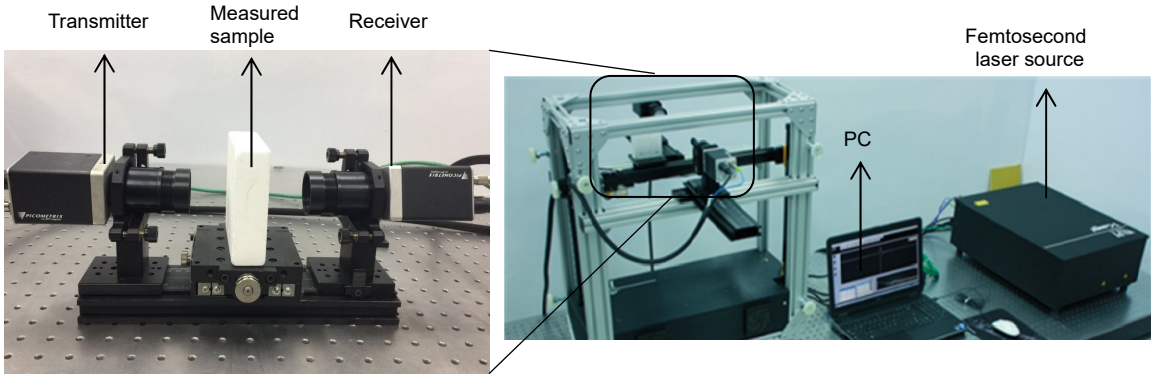

Transmission THz time-domain spectrum detection system

Overview: Terahertz time-domain spectroscopy (THz-TDS) is a spectral detection method. The information of the material is measured through the broadband terahertz pulse carrying the medium information (such as amplitude and phase). Terahertz waves have the characteristics of strong penetrating power, safety and spectral resolving power, and have been rapidly developed and applied in recent years. They have become the new forces of material property analysis and non-destructive testing technology and have been applied to national defense, industry and telecommunications, biomedicine, pharmaceuticals, agricultural products and foodstuffs. In this paper, the transmission test method is used to test and analyze the tested materials. The main tested materials used in the experiment include ceramic matrix composites and silica gel materials, which are commonly used in thermal protection systems in aerospace and aerospace fields. In this paper, the optical parametric model of material was established based on terahertz time-domain spectroscopy detection system. The refractive index and absorption coefficient of the material were extracted. The curves of refractive index and absorption coefficient with frequency were plotted based on the obtained optical parameters. The results show that the refractive index of ceramic matrix composites with different densities are respectively stable at a constant of 1.11, 1.14 and 1.16. The refractive index of silica gel with different thickness is 2.10. This is in line with the principle of basic physics. By observing the refractive index of the material and absorption coefficient of the curves, the same density material refractive index does not exist frequency dependence, and the absorption coefficient of the frequency dependence is strong, it increases with increasing frequency, and there is a peak point. Secondly, in order to extract the optical parameters of the extracted material accurately, and understand the error existing in the extraction process, the systematic errors occurred in the experiments were identified and modeled based on the theory of Gaussian error. The characteristic errors of the optical parameters of the ceramic matrix composites with a density of 2.8 g/cm^3 were analyzed. The errors including the amplitude error and the thickness error, each part of the error source will contribute to the final error. The results show that the standard deviation of refractive index is steady, and the standard deviation of absorption coefficient changes obviously with the frequency, and the standard deviations are in the order of 0.001. This is of great significance for accurate extraction of optical parameters and other physical quantities.

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