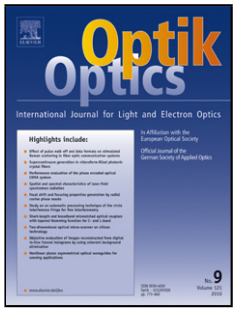

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Terahertz spectroscopic study of aeronautical composite matrix resins with different dielectric properties

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Abstract. This study was to investigate the spectral characteristics of aeronautical composite matrix resins (ACMRs) that differ in dielectric properties in terahertz frequency range. Terahertz time-domain spectroscopy was employed to examine the spectral absorption and dielectric dispersion characteristics of five ACMRs of three major types, namely, epoxy resins 3238A and BA9916, cyanate ester (CE) resin 9915, and bismaleimide (BMI) resins QY8911 and QY9611, between 0.2 THz to 1.6 THz. The refractive index n, the absorption coefficient α and the real part ε' and imaginary part ε'' of the dielectric constant of each resin were calculated. On this basis, the relaxation process of dipoles was theoretically analyzed using the Debye model. The results showed that, ε'' of each epoxy resin was higher than that of each BMI resin, while ε'' of the CE resin was the lowest. The CE resins had the lowest ε' and exhibited the highest and most stable dielectric performance, followed by the BMI resins, whereas the epoxy resins exhibited fluctuating and slightly less stable dielectric performance. This study gives, for the first time, the basic parameters of five ACMRs (epoxy, CE and BMI resins) in terahertz frequency range, and provides an important reference for THz nondestructive testing of aeronautical composites.

Keywords: Terahertz time-domain spectroscopy, Dielectric properties, Aeronautical composites, Matrix resins, Debye model.

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1 Introduction

Today, continuous fiber-reinforced resin-based composites are applied extensively in various areas of the aviation industry. Due to their exceptional specific strength, specific modulus, fatigue resistance, corrosion resistance and shock resistance, these composites are used to produce important components of various load-carrying structures in aircraft, including integrated structural/wave-transparent components such as wing covers, horizontal tails, vertical fins, rudders, antenna housings and radomes[1]. With performance far higher than resins used in other fields, aeronautical composite matrix resins (ACMRs) are a type of modified resin system produced by adding hardeners, modifiers, catalysts and flexibility additives to improve a resin's