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Terahertz performance of porous anodic alumina films formed in electrolytes containing formic acid

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Alumina/carbon composites are modern nanomaterials used as adsorbents, catalysts, catalyst supports, supercapacitors, and electrode materials for fuel cells. Among other methods, aluminum anodizing is fairly fast and inexpensive for producing anodic alumina/carbon composites with controllable properties [1]. The electrolyte anions are incorporated into the alumina during aluminum anodizing. Depending on the electrolyte type, the electrolyte species can be immobile and migrate inward or outward throughout the oxide under the electric field, thus affecting the morphological, optical, and physical-chemical properties of the alumina films [2,3]. The scattering of THz waves on a rough surface of dielectric substrate was found to be the main mechanism determining the optical losses of laser-ablated high-resistivity silicon [4].

In this work, the porous anodic alumina films formed in electrolytes containing formic acid (FA) and ammonium heptamolybdates (AHM) or oxalic acid (OxA) were investigated by THz TDS (T-SPEC 800, TeraVil) in the frequency range of 0.1–4.0 THz. Alumina films were measured at a normal incident angle in transmission and reflection geometry with a spot size of around 3 mm. The transmission spectra for selected samples are shown in Fig. 1. Optical thickness (product of film thickness and refractive index) was measured for FA+AHM and FA+OxA samples of about 40 μm and 50 μm, respectively. Taking into account the physical thickness of 16 μm for both FA+HMA and FA+OxA samples, the refractive index was found to be about 2.5 and 3.2, respectively. The thickness uniformity and surface roughness which induce scattering losses require additional investigation. On other hand, the carbon content can explain the difference in the transmission spectra, as value of it was two times lower in the films containing oxalic acid as an additive to the formic acid compared to the films obtained in the mixture of formic acid and ammonium heptamolybdate.

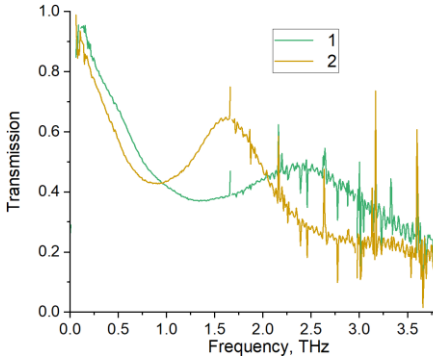

Fig. 1 Transmission spectra of porous anodic alumina films formed in FA+AHM at 80 V (1) and in FA+OxA at 80 V (2).

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