Optical Permittivity and Permeability in the THz Band

from Independent Measurements of Normal Transmission and Reflection

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An accurate retrieval procedure has been developed in order to extract both the dielectric and magnetic response of thin and thick samples in the THz band. Differently from a previous approach [1], the exact expressions of the complex reflection $\tilde{R}$ and transmission $\tilde{T}$ of the THz beam normally impinging on the sample surface are used. The core of the methodology consists in the independent employment of the experimental $\tilde{R}$ and $\tilde{T}$ values, processed by a total variation technique [2] to retrieve the complex impedance $\tilde{z} $and refractive index $\tilde{n}$, namely $\tilde{z}\_{R},$ $\tilde{z}\_{T}$, $\tilde{n}\_{R}$, $\tilde{n}\_{T}$. From here the dielectric function $\tilde{ε}$ and permeability $\tilde{μ}$ are obtained through $\tilde{ε}\_{i}=\tilde{n}\_{i}\tilde{z}\_{i}$, $\tilde{μ}\_{i}=\tilde{n}\_{i}/\tilde{z}\_{i}$ ($i=R, T$) to achieve $\tilde{ε}\_{R}$, $\tilde{ε}\_{T}$, $\tilde{μ}\_{R}$, $\tilde{μ}\_{T}$. The technique is applied to a thin film of BiFeO3 showing a small but finite magnetization and a phononic resonance at about 2 THz [3]. The BiFeO3 films have been grown on quartz, following a procedure similar to that previously optimized for the deposition on Si (100) substrate [4]. In particular, the films have been deposited in the temperature range 600–800 °C for 60 min using the Bi(phenyl)3 and Fe(tmhd)3 (phenyl = –C6H5, H-tmhd = 2,2,6,6-tetramethyl-3,5-heptandione), as precursors. The X-ray diffraction patterns, recorded in grazing incidence mode (0.8°), have confirmed the formation of pure, polycrystalline BiFeO3 films, while the field emission scanning electron microscopy image indicates the presence of grains of about 500-600 nm.

References

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