The Optical and Dielectric Response of ZrO_2 in Terahertz Region

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ABSTRACT

By means of Terahertz time-domain spectroscopy, the power absorption coefficient and refractive index of Zirconia were obtained.Meanwhile the complex dielectric function related those were also obtained. By analysis of the experimental data, a new phonon vibration mode at around 1.5THz were firstly observed. Furthermore, using the Drude-Lorentzian Model the contrast between the theoretical calculated data and the experimental data were plotted and discussed.

FIGURES

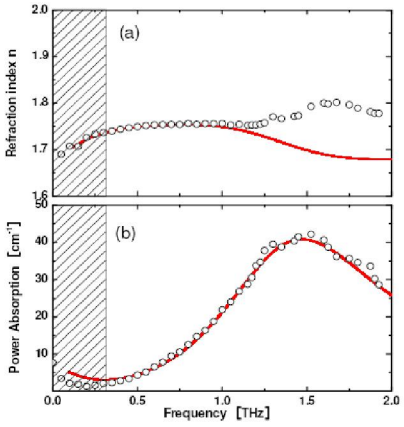

Figure.1: The refractive index n(ω) and power absorption α(ω)

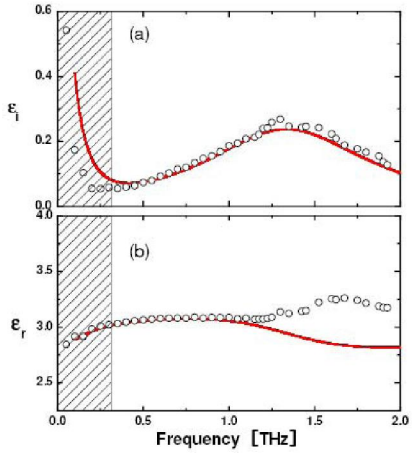

Figure.2: The imaginary and real parts of complex dielectric function. (a) $\varepsilon_i(\omega)$, (b) $\varepsilon_r(\omega)$

For Drude-Lorentzian model, the dielectric function is described by:

$$\varepsilon(\omega)=\varepsilon_c-\omega^2_p/(\omega^2+i\Gamma\omega)-\omega^2_{p1}/[(\omega^2-\omega^2_1)+i\Gamma_1\omega]$$

where ε_c represents the frequency-independent optical dielectric constant. The second term is Drude term where ω_p and Γ are the plasma frequency and the relaxation rate of the charge carries. It defines the delocalized charge component. The third term is the Lorentz harmonic oscillators for simulating the interband transition and vibrational structure; here we only consider the first-order of the lorentz oscillators. Using the above equation, the dielectric function were calculated and plotted. In Ref [10],a calculational soft-mode X_2^- was introduced. At X point (0, 0, 1/2) of the Brillouin zone, there is a low frequency vibration which has the value of 41 cm^{-1}.it is very closed to the value of ours which is about 48cm^{-1}. Now using THZ-TDS we have experimental gotten a phonon vibration mode in THz region. The imaginary and real parts of dielectric function ε_i and ε_r also fits the experimental data well even in a detailed region.

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