Phonon Reflection Light by Crystals

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The method of infrared reflection of light is widely used to determine the crystal optics constants. Owing to transverse nature of light, as well as silmultaneous obeying the laws of energy and impulse conservation when a photon is absorbed by crystal lattice, the only transformation of the photon into transverse optical phonon is possible, and accordingly, in the given spectrum region dielectric permittivity $\varepsilon(\omega)$ has resonant shape

$$\varepsilon(\omega)=\varepsilon_\infty + (\varepsilon_0 - \varepsilon_\infty)\, \omega_{TO}^{\ 2}/(\omega_{TO}^{\ 2} - \omega^2 - i\gamma\omega)=(\varepsilon_1 + i\varepsilon_2).$$

Where ε_0- is static, ε_∞ - is dinamical dielectric permitivities of a crystal, ω_{TO} - is resonant frequency of optical transverse phonon, γ- is damping factor.
There is the energetic gap where real part $\varepsilon_1(\omega)$ of complex dielectric permitivity $\varepsilon(\omega)$ has negative value. The negative values $\varepsilon_1(\omega)$ causes creation of light reflection contour maximum $R(\omega)$ in infrared region of spectrum.

In the presented work it is shown that the above is valid only for zero damping magnitude and is not correct for $\gamma\neq0$. The following model is proposed. When crystal is irradiated by incoming electromagnetic wave, the crystal bulk emits secoundary polariton wave that interferes with primary one reflected by crystal surface and resonant spectrum of phonon reflection is formed. Primary wave due to the crystal surface reflection is shifted in phase on π. Therefore primary wave in the region out of polariton-phonon resonance is in the same phase as polariton wave. Close to resonant frequency of longitudinal phonons ω_{LO} the phase of polariton wave decreases. Resonant shift of the phase between basis and polariton waves determines the resonant character of interference contour of light reflection in the spectrum region of TO-phonon excitation.