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INFRARED LATTICE VIBRATION OF VAPOUR-GROWN AlN

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Thick films of AlN crystal have been deposited by the vapour-phase reaction. The restrahlen band of AlN has been found through the reflectivity measurement in the infrared region. The values for ω_T, ω_L, ϵ_0, ϵ_∞, Γ and e* are also determined.

POLYCRYSTALLINE AlN films were prepared on glassy carbon substrates by the vapour-phase reaction in N_2 stream, using $AlCl_3$ and NH_3 as source materials.[1] Films deposited at about 1050°C consisted of many crystallites of high-resistivity AlN. An example of their X-ray diffraction patterns is shown in Fig. 1.

Infrared reflectivity, R, was measured at room temperature with such a film, whose thickness was about 200 μ. This thickness is enough for the reflectivity measurement. The wavelength dependence of reflectivity is shown in Fig. 2, in which one can see the reststrahlen band of AlN. The solid line in this figure is calculated from the following equations.

$$\epsilon(\omega) = \epsilon_\infty + \frac{\epsilon_0 - \epsilon_\infty}{1 - \left(\frac{\omega}{\omega_T}\right)^2 - i\Gamma\left(\frac{\omega}{\omega_T}\right)} ,$$

$$R = \frac{\left| \epsilon^{\frac{1}{2}}(\omega) - 1 \right|^2}{\left| \epsilon^{\frac{1}{2}}(\omega) + 1 \right|^2} ,$$

where $\epsilon(\omega)$ is the dielectric constant due to interaction only with the lattice vibration. The values for the angular frequency of the transverse optical phonon, ω_T, the static and optical dielectric constants, ϵ_0 and ϵ_∞, and the damping factor for the lattice vibration, Γ, can be determined by fitting the calculated reflectivity to each experimental one, as seen in Fig. 2. Thus the angular frequency of the longitudinal optical phonon, ω_L, and the Szigeti's effective ionic charge, e*, are also calculated. These numerical values are compiled in Table 1.

TABLE 1

Summary of physical properties of AlN at room temperature

	Present work	Former results
ω_T	1.25×10^{14} sec^{-1}	—
ω_L	1.69×10^{14} sec^{-1}	—
ϵ_0	8.50	~8.5[2]
ϵ_∞	4.68	n^2 = 4.67[4]
Γ	0.01	—
e*	1.17	~1.2[3]

As seen in Table 1, the values for ϵ_0 and for e*, agree well with the respective ones, which were previously determined from the electrical[2] and from the optical measurements[3], respectively. The value for ϵ_∞ is equal to the square of the refractive index, n^2, determined by the optical method.[4]

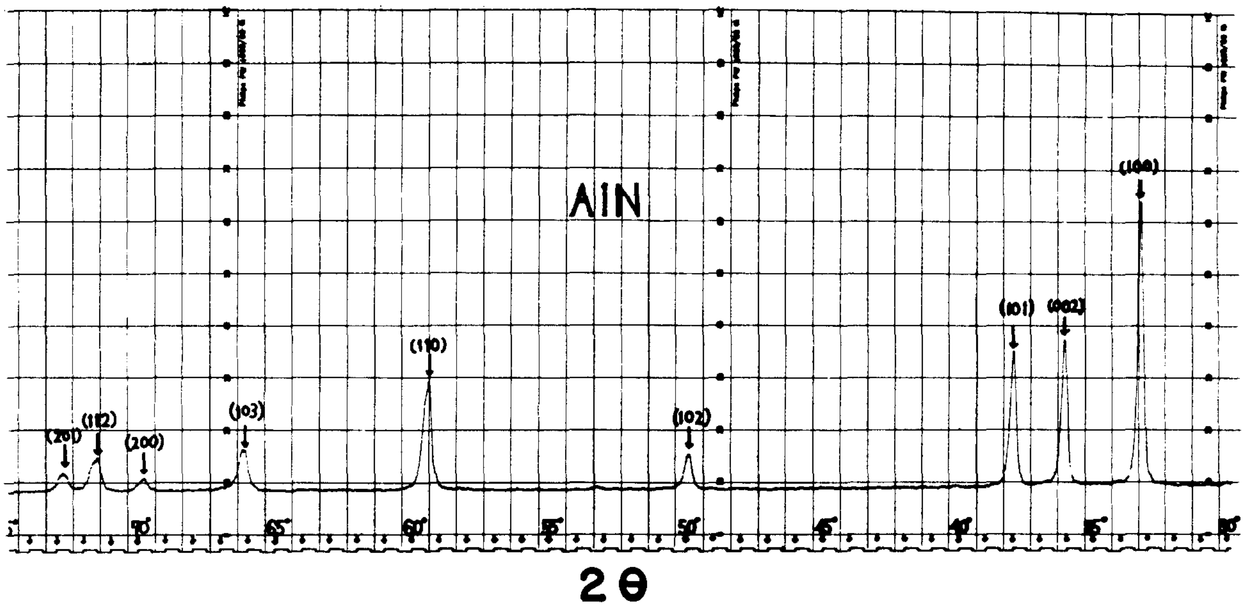

FIG. 1

X-ray diffraction pattern of vapour-deposited AlN. Cu-Kα was used. Abscissa is twice the diffraction angle, 2 θ.

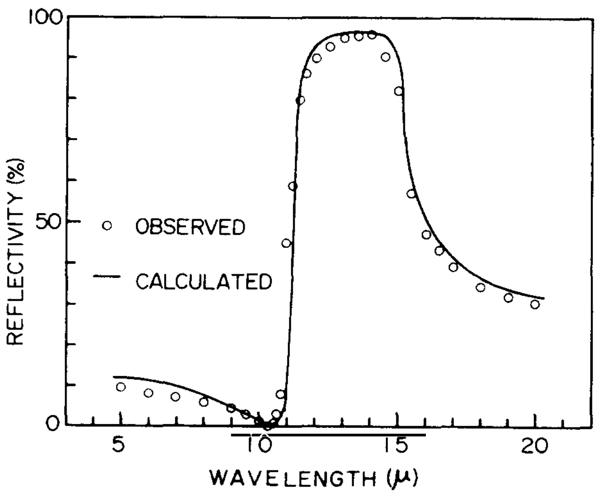

FIG. 2

Wavelength dependence of reflectivity of AlN film. Circles are experimental values, solid line calculated.

References

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Dicke Filme des AlN Kristalls sind von der Dampfphase-Reaktion abgesetzt worden. Das Reststrahlenband von AlN ist durch die Reflexionsmessung im Ultrarot-Gebiet gefunden worden. Die Werte für ω_T, ω_L, ϵ_0, ϵ_∞, Γ und e^* werden auch bestimmt.