POLARIZATION OF 3050 Å EMISSION FROM KCl:Tl UNDER UNIAXIAL STRESS

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In this note we report the observation of polarization in the 3050 Å emission from KCl:Tl at room temperature when the crystal is brought under uniaxial stress. The polarization varies linearly with stress, is dependent on the orientation of the stress and the direction of observation with respect to the crystal axes, and varies inversely proportional to temperature between 300° and 450°K. These results indicate that the excited state involved in the emission process is degenerate in a strainfree crystal and the degeneracy is lifted by the uniaxial stress.

The polarization was measured with a sensitive differential method [1] permitting the measurement of changes in the degree of polarization of about 0.01% KCl single crystals, doped with Tl concentrations of 0.003% and 0.0015% were obtained from K. Korth, Kiel, Germany. Samples were prepared in the form of bars along [100], [110], and [111], the dimensions being about $4 \times 4 \times 10$ mm^3. Uniaxial pressure was applied with a small hydraulic press. Pressures were limited to 100 kg/cm^2 to avoid plastic deformation. Excitation of the crystals took place in the 2470 Å band by the radiation from a hydrogen lamp through a chlorine vapour filter (2 cm, 6 atmosphere). Fluorescence was observed at right angles to the excitation and the stress through a filter Jena UG 11. Experimental results are summarized in table 1, which gives the polarization $P = (I_{\parallel} - I_{\perp})/(I_{\parallel} + I_{\perp})$ for various orientations and at 100 kg/cm^2. Error margins indicate the spread between various samples. Once a particular sample was mounted, measurements were reproducible to within 0.02%. All polarizations varied linearly with stress to this accuracy. No systematic difference was observed between the two dopings. For stress along [100] and [111] measurements were made as a function of temperature between 300° and 450°K. The polarization was found to vary nearly as $1/T$.

The experimental results can be explained by assuming that the excited state is degenerate in the absence of stress. Stress lifts the degeneracy and a linear splitting results. If the substates have different polarization characteristics with respect to emission, the emitted radiation will be polarized because of the difference in Boltzmann factor. At high temperatures the stress will vary as $1/T$. When we assume the substates to emit totally polarized radiation the splitting would amount to 2 cm^{-1} for 100 kg/cm^2 along [100]. This may be compared with the width of the emission band at 300°K, which is about 3300 cm^{-1}. The experiment therefore demonstrates the sensitivity of this type of measurement for observing small splittings. A degenerate state in the cubic symmetry is likely to undergo a Jahn-Teller deformation [2, 3]. A degeneracy is then left in the equivalence of several directions along which this distortion can take place. Stress removes this equivalence and an argument similar to the one given above can be used to explain the polarization. The results for stress along [100] and [110] can be understood qualitatively assuming a Jahn-Teller deformation along [100]. Since all [100] directions are equivalent for stress along [111], one would then expect zero polarization for this stress direction, which is in contradiction with the experiment. Further work is needed to clarify

Table 1

Pressure along	Direction of observation	P at 100 kg/cm^2 (%)
[100]	[010],[001],[010],[001]	+0.65 ± 0.05
[110]	[110] and [110]	+0.30 ± 0.15
[110]	[001] and [001]	-0.05 ± 0.15
[111]	[110],[110],[112],[112]	-0.17 ± 0.02

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this point. As to the nature of the excited state responsible for 3050 Å emission, this was originally thought to be the $^3\Gamma_4$ state, the same state that is involved in the absorption at 2470 Å and which is derived from the free Tl^+ ion $^3P_1$ state. Recent spectroscopic measurements [4] however, as well as lifetime measurements [5] indicate that above 80°K the emission takes place from a different state, possibly not corresponding to an excited state of the Tl^+ ion. In any case it may be concluded that the measurement of stress induced polarization may yield valuable information concerning the degeneracy and the symmetry of the excited state. We intend to extend these measurements, especially to lower temperatures, to obtain more complete information.

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DETERMINATION OF STAGE I RECOVERY IN PURE ALUMINUM FOLLOWING ELECTRON IRRADIATION *

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The purpose of this paper is to report the determination of the Stage I recovery spectrum in high purity aluminum (99.9999%) following electron irradiation. Most of the experiments on Stage I have been carried out on copper, and this stage has not yet been determined very carefully in aluminum. It is of interest to compare the present results with recent results on 99.999% copper [1]. Similarities as well as differences are found. However, the general qualitative behaviour appears to be the same in both metals. The ultimate objective will be to explain the differences on the basis of the different atomic and bulk parameters of the two materials.

The experimental techniques were the same as used before [1]. The recovery rate of the electrical resistivity induced by 2 MeV electrons

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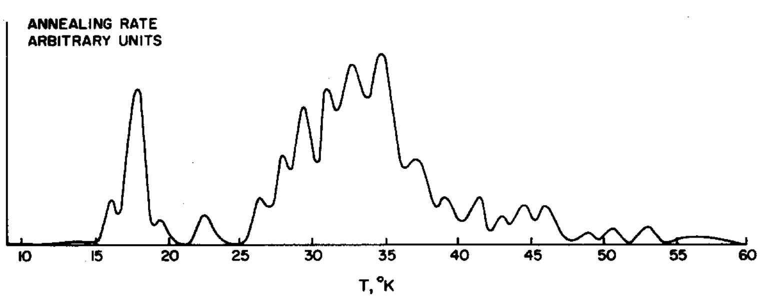

Fig. 1. Typical curve giving rates of electrical resistivity recovery in electron irradiated aluminum, following a low electron dose at 2 MeV. The same peaks were observed for different dose levels at 2 MeV as well as for a 0.7 MeV irradiation.