Epitaxial Growth of Cadmium Sulphide Films

FILMS of cadmium sulphide prepared by conventional methods, such as sublimation, sputtering and co-evaporation, normally consist of material which, because of its polycrystalline structure, yields devices which compare unfavourably with their bulk single crystal counterparts. To overcome this, a method for the growth of single crystal films has been developed which, although originally intended for cadmium sulphide, is applicable to other II–VI compounds.

The selected high purity charge is enclosed with a compatible substrate in a quartz capsule sealed except for a small orifice (0.1 mm in diameter) which communicates with a concentric outer vacuum chamber. This assembly is lowered into a furnace of high thermal capacity, comprising a low voltage resistance heated element surrounded by thermally insulating fire brick. The furnace temperature is profiled to ensure a slight increase in temperature immediately above the charge to prevent condensation in the orifice, and a steep temperature gradient, 15° C cm^{-1}, at the substrate to prevent constitutional supercooling. Long term stability in temperature is less important than the ability to raise the inserted capsule quickly to the required temperature. Further heating of the assembly to 1,000° C, while maintaining the substrate at a lower temperature than the charge, causes the excess sulphur, released as the charge begins to sublime, to condense on the cooler walls of the outer vacuum chamber. This has the effect of slightly displacing the charge composition towards the cadmium axis on the cadmium sulphide phase diagram; equilibrium is reached when the charge and vapour exhibit identical compositions. The system may be charged to a predetermined pressure with an inert gas to limit the diffusion rate of the charge and hence control the growth rate of the film.

The results are, of course, highly dependent on substrate condition, and depositions on sapphire substrates have revealed three requirements that must be satisfied simultaneously if single crystal films are to be grown. First, there must be favourable crystallographic orientation of the substrate; second, the substrate must be free from surface damage; and third, the substrate temperature must be sufficiently high (> 850° C).

Fig. 1 shows a back reflexion X-ray Laue diffraction pattern obtained from a layer 110 μm thick and 1 cm in diameter, which was grown in 20 min; it clearly illustrates the single crystal nature of the films.

In these experiments the cadmium sulphide films were grown with the $(10\bar{1}2)$ plane parallel to the $(11\bar{2}0)$ plane on a sapphire substrate. A similar diffraction pattern of the $(10\bar{1}2)$ orientation obtained from a single crystal boule of cadmium sulphide is shown in Fig. 2 for comparison. Optical examination using polarized light revealed no crystallites over the entire area of the film. Moreover, if the stated requirements are met, the results are readily reproducible.

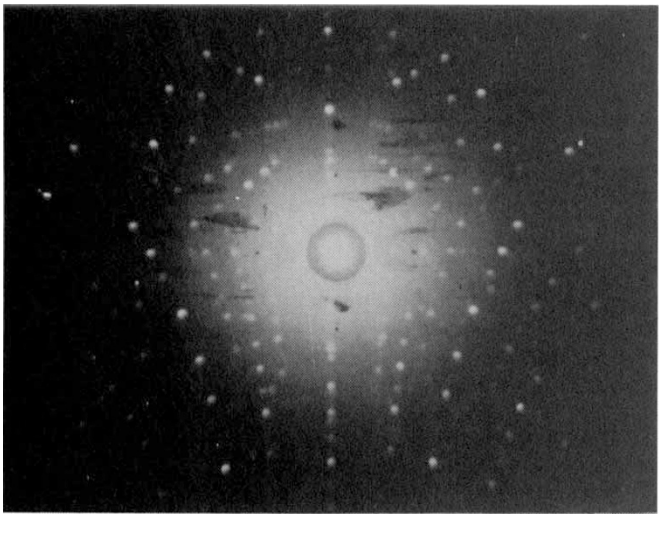

Fig. 1

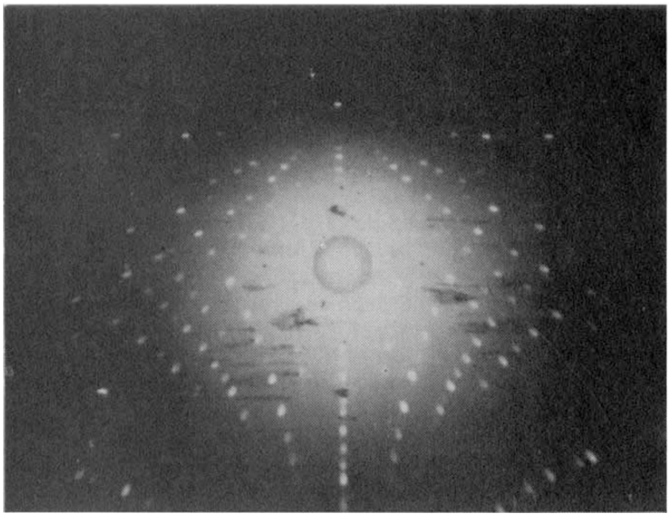

Fig. 2

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Erratum

IN the article "Production of a Diffuse Flux of Soft X-Rays by Galactic Objects" by John E. Mack (*Nature Physical Science*, **235**, 144; 1972), the last sentence in the section on Stars, Association and Remnants on page 146 should read: "In fact, Apparao uses it as a model for Sco X-1".

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