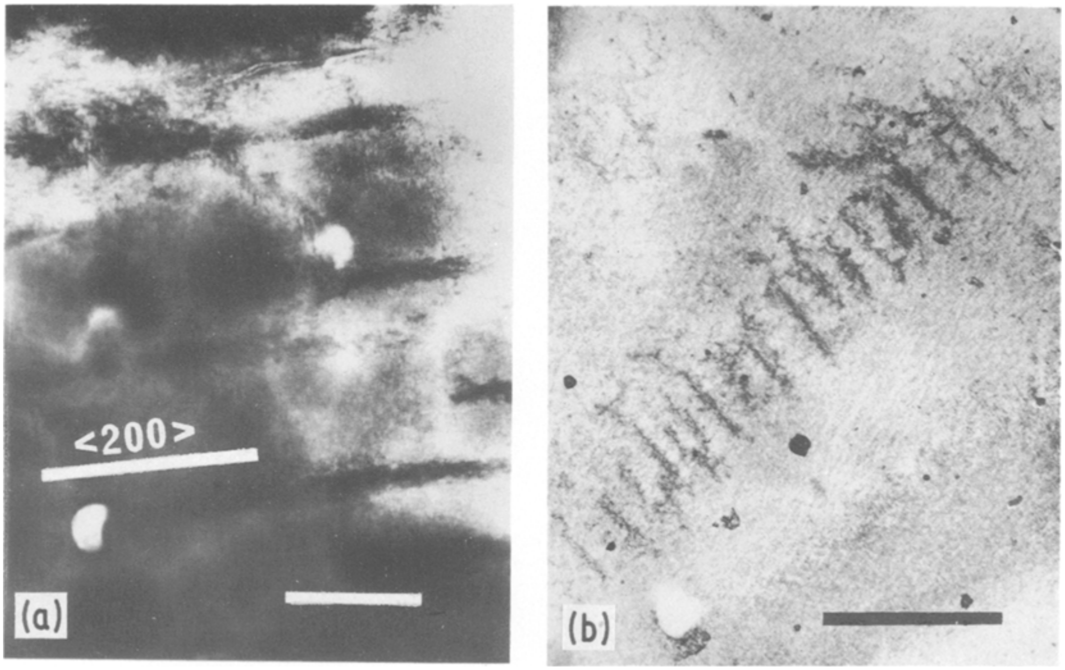

Figure 4 Bright-field TEM showing the base of scratches in (a) Mg-PSZ and (b) Ca-PSZ. Bar length equals five micrometer.

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R. H. J. HANNINK
M. V. SWAIN
CSIRO Division of Materials Science
Melbourne
Australia

Optical properties of palmitic acid thin films

Long-chain fatty acid films find numerous applications in optical devices [1–5]. The optical properties of thin films of palmitic acid formed by the Langmuir and Blodgett technique [6–9] and by vacuum evaporation [10] have been studied by various workers. In the present investigation the ion-plating technique [11] has been adopted to obtain the palmitic acid thin films and their optical properties are studied in detail.

Pure palmitic acid (99.5%; Eastmann, Kodak, New York) was evaporated from a molybdenum boat using an ion-plating technique in the presence of r.f. glow and deposited on to well-cleaned glass slides. The vacuum was maintained at about 2×10^{-2} Torr. The r.f. power was kept at 150 W

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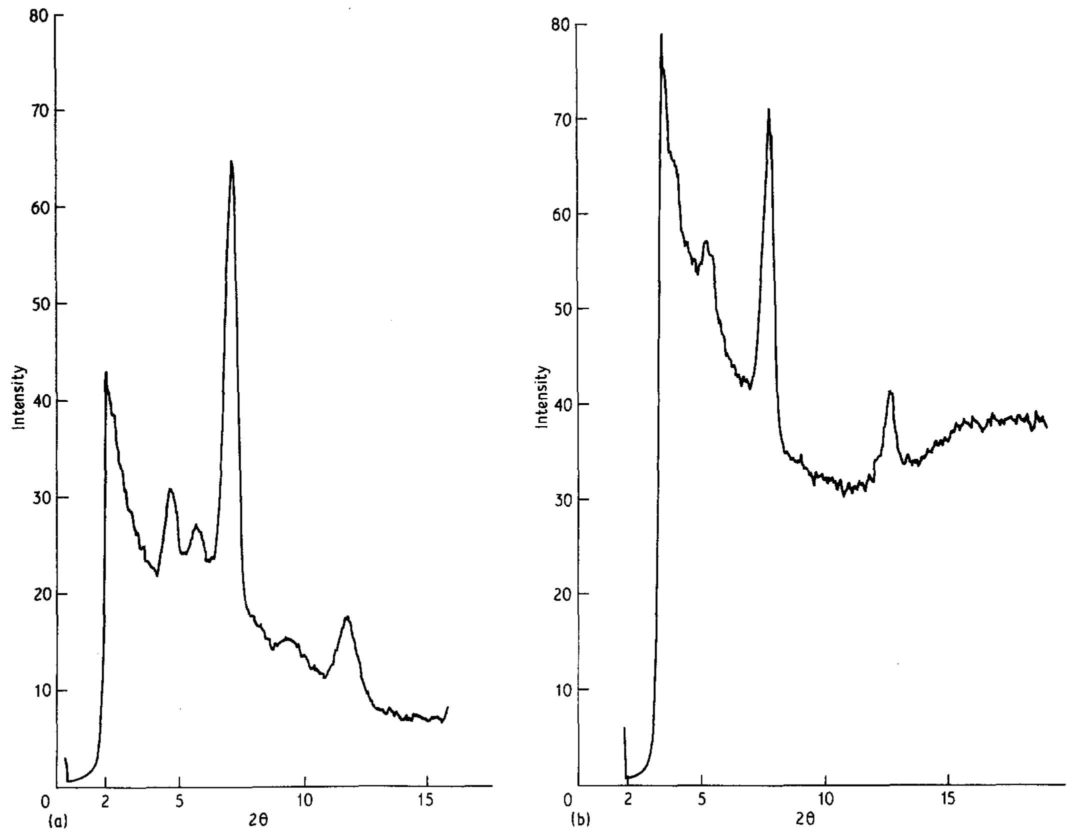

Figure 1 X-ray diffractograms for (a) bulk palmitic acid and (b) ion-plated palmitic acid film.

and the substrates were biased to 150 V. The thickness of the films has been measured using a multiple-beam interferometer. A structural analysis of the film has been carried out using an X-ray diffractometer. A Shimadzu-UV-Vis double-beam spectrophotometer was used to measure the transmittances of the films of various thicknesses (60–200 nm) in the visible region.

The absorption index (k_f) has been evaluated from Lambert's equation. The refractive index (n_f) has been determined from the following relation [12]

$$T_0/4n_b = \left[(n_b + 1)\cos\frac{2\pi d}{\lambda}(n_f + ik_f) - i\left(\frac{n_b}{n_f + ik_f} + n_f + ik_f\right)\sin\frac{2\pi d}{\lambda}(n_f + ik_f)\right]^{-2}$$

where T_0 is the transmittance, k_f the absorption index, λ the wavelength of the light and n_b and n_f represent the refractive indices of the substrate and film respectively. The corresponding moduli have been used for the complex terms.

Palmitic acid films formed at room temperature were found to be transparent. Fig. 1 shows the X-ray diffractrograms for (a) palmitic acid powder and (b) the ion-plated film. From the figure it can be seen that the crystalline structure is maintained without any decomposition due to the evaporation process. From Fig. 2 the transmittance in the visible region has been found to be fairly high (> 90%) and increases slowly with wavelength. At higher wavelengths it tends to become constant thereby suggesting that the films are less absorbing at higher wavelength. The variation of log (transmittance) with film thickness is represented in Fig. 3. From the plot, the absorption index (k_f) and absorption coefficient (α) have been estimated. The absorption indices in the region 700–400 nm (Fig. 4) have been found to be extremely low (the value lies between 0.0095 and 0.0145) and hence have been neglected in the

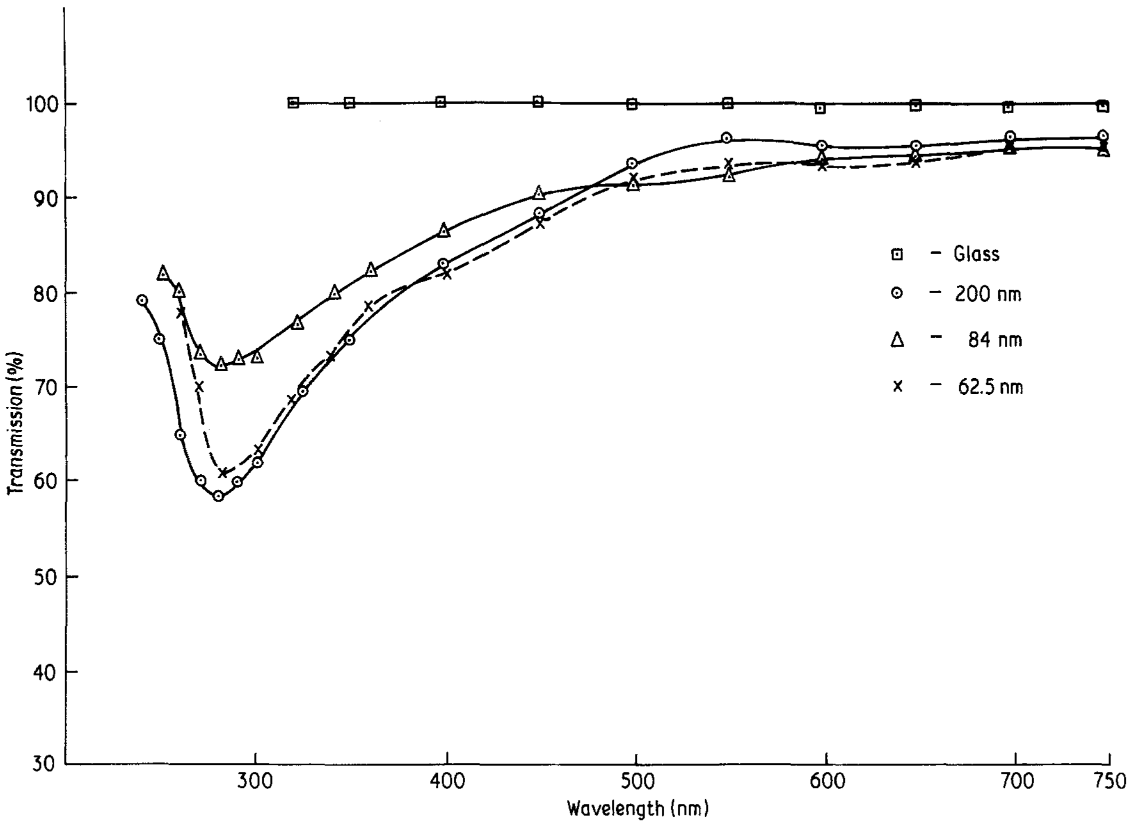

Figure 2 Variation of transmittance with wavelength for films of different thicknesses.

evaluation of n_f. Fig. 4 shows the variation of n_f with λ for films of different thicknesses: it is found that thinner films have lower values of refractive indices. This may be due to the presence of voids and discontinuities in thinner films [13].

It is interesting to note that the refractive index (1.551) of the film (62.5 nm) at a wavelength of 600 nm is quite comparable with that (1.557) obtained for monolayer film of thickness 2.2 nm [14, 15]. The higher values of the refractive indices of the films in comparison with that of the bulk material [16] (1.4335) may be due to the porous nature of the film [17–20] and rise of substrate temperature [21–23] during the film formation. It is well known that the highly transparent films will have their absorption edge in the u.v. region [24]. This is in conformity with the present observation (Fig. 2) made with palmitic acid films. From the α^2 versus $h\nu$ plot (Fig. 5) the value

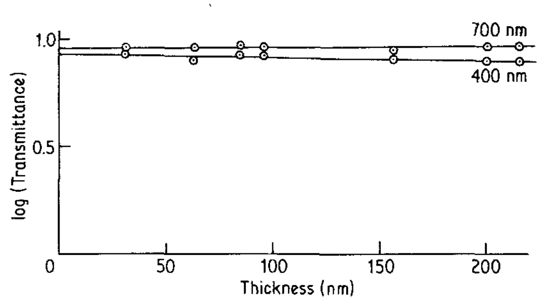

Figure 3 Variation of log T with film thickness d.

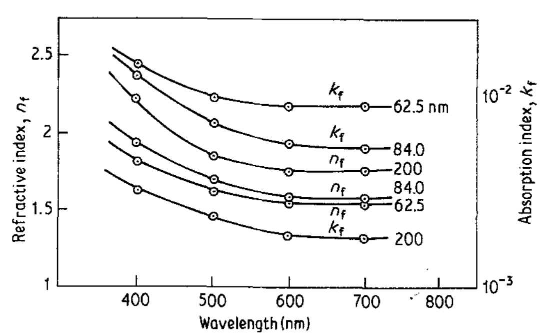

Figure 4 Variation of n_f and k_f with wavelength λ.

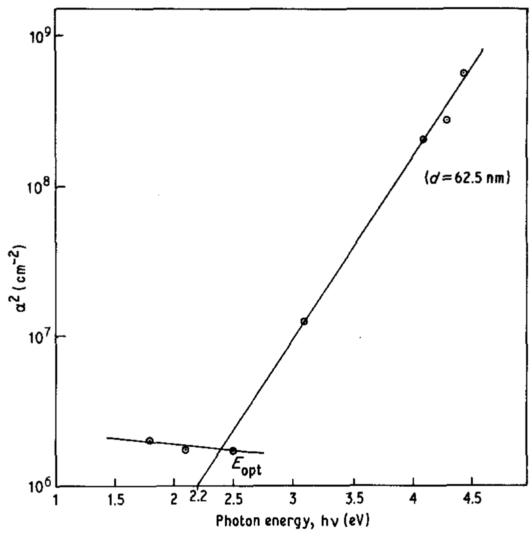

Figure 5 Variation of α^2 with photon energy $h\nu$.

of E_{opt} has been estimated as 2.2 eV [25, 26]. As the glass does not show any absorption in the u.v. and visible regions above 320 nm (Fig. 2), it can be inferred that the value of E_{opt} is not affected by the glass substrate.

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A. R. RAMARAJU
C. BALASUBRAMANIAN
M. RADHAKRISHNAN
Department of Physics,
Madras University Autonomous P.G. Centre,
Coimbatore - 641041,
India