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IODINE DOPING-DEDOPING OF THIN LAYERS OF $(AlPcF)_n$

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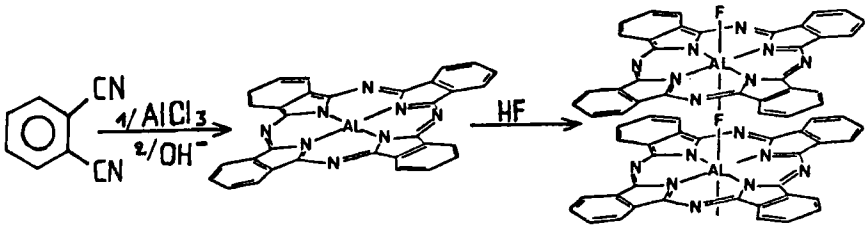
Abstract The polyphthalocyanine $(AlPcF)_n$ was deposited on various substrates as layers a few hundred Å thick. An increase of the conductivity is observed when such layers are submitted to a I_2+N_2 gaseous mixture. The dedoping is performed by sweeping with pure N_2. The partly reversible and I_2 pressure dependent doping-dedoping process can be analysed in terms of Langmuir's theory.

SYNTHESIS AND CHARACTERIZATION

Synthesis was performed according to J.P. Linsky et al.[1] :



The polymer was sublimated under vaccum ($\sim 10^{-5}$ Torr) on substrates such as alumina, quartz, KBr, glass,.... The thin layers obtained were characterized by I.R. (fig. 1) and U.V. (fig. 2). An amorphous structure of the polymer is observed by X rays. The d.c. conductivity is about $\sigma \sim 10^{-4}(\Omega cm)^{-1}$.

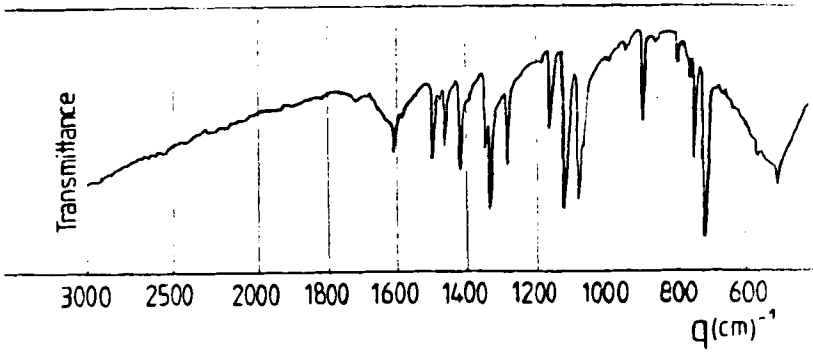


FIGURE 1 I.R. Spectrum of thin films : it is the same as the spectrum of the powder published by D.C. Weber et al.[2]

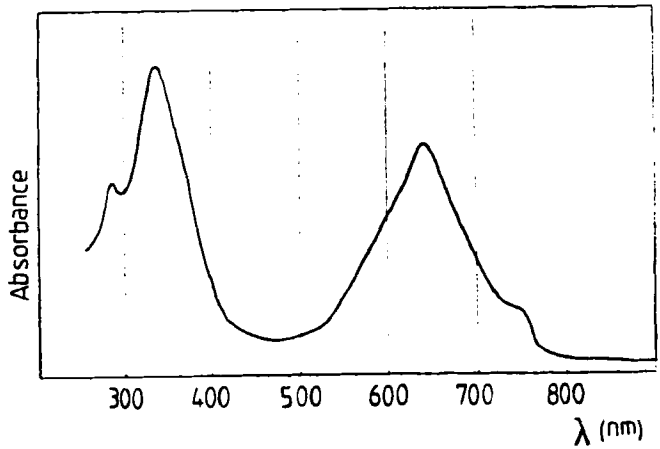


FIGURE 2 U.V. Spectrum of thin films : the first maximum (at 340 nm) depends on the nature of the metal, the other one (at 650 nm) is attributed to the $\pi \rightarrow \pi^*$ transition.

IODINE DOPING AND DEDOPING

Layers were doped at 50°C by a gaseous mixture N_2+I_2 obtained by a flow of N_2 through a column of solid iodine. The dedoping process was realized by a flow of pure N_2 at the same rate than that of the mixture (150ℓ/h). The maximum partial pressure of I_2 in the doping mixture was about 0,3 Torr corresponding to the saturated iodine vapour at 20°C. Alumina substrates with Au interdigitated electrodes were used for electrical conductivity measurements.

Experimental results

Layers were submitted to cycles including a five minutes doping time followed by a five minutes dedoping one. At the end of the doping time the conductivity reaches a stable value of $1.2.10^{-1}(\Omega cm)^{-1}$, for a I_2 partial pressure of 0,3 Torr. (fig. 3).

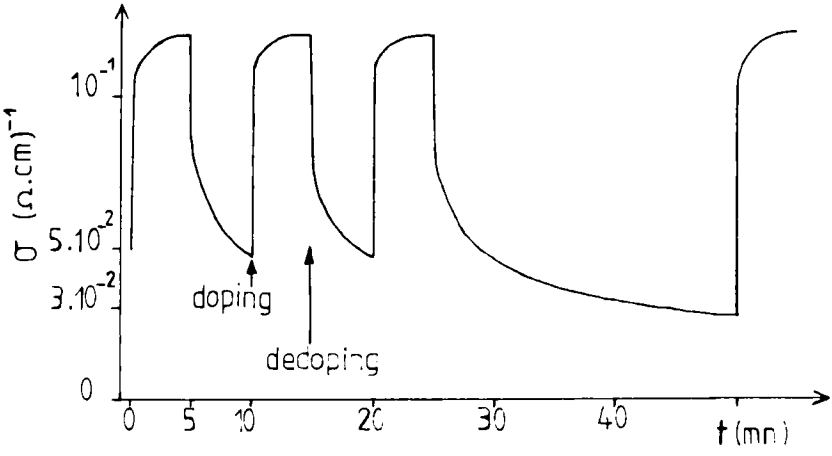


FIGURE 3 σ versus time for doping and dedoping cycles.

We note that the doping-dedoping process is partly reversible and characterizedby relatively short time constants (the rising time is about 1 minute). The limit value of σ depends on the I_2 partial pressure in the gaseous mixture. In the range 0,06 - 0,3 Torr. σ obeys the law :

$$\sigma \underset{\sim}{\alpha} P_{I_2}^{\alpha} \quad \text{with } \alpha \simeq 0,3$$

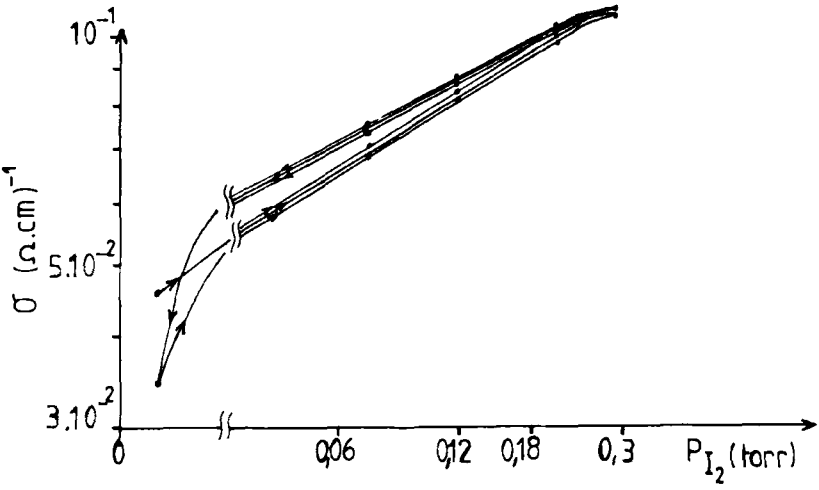


FIGURE 4 σ versus the I_2 partial pressure

These preliminary results, related to the number of iodine atoms having caused a charge transfert with the polyphthalocyanine,have been analysed in terms of Langmuir's theory.

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2. D.C. Weber, P. Brant, R.S. Nohr, S.G. Haupt and K.J. Wynne, J. Phys. 44, C3-639 (1983).