STUDY OF THIN FILMS PREPARED IN GLOW DISCHARGE FROM HYDROCARBONS[1)]

ИССЛЕДОВАНИЕ ТОНКИХ ПЛЕНОК ИЗ УГЛЕВОДОРОДОВ, ПРИГОТОВЛЕННЫХ В ТЛЕЮЩЕМ РАЗРЯДЕ

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Thin polymer films were obtained by polymerization in a glow discharge in an argon-xylen (resp. hexan) mixture. The films were prepared on biased substrates. Plasma parameters of the mixtures are studied.

During the past few years polymer thin films have been prepared in electrical discharges, both in the RF discharge (e.g. [1, 2]) and in the DC glow discharge (e.g. [3, 4, 5]). In these papers the properties of hydrocarbon vapour-carrier gas mixtures are studied and properties of obtained thin films analysed. In our case, the thin films were prepared in the stationary glow discharge of an argon-xylen mixture with the help of biased substrates or by pyrolysis in hexan vapours, respectively.

The films were prepared in a simple "T" form glass system. In the longer part platinum electrodes and two couples of probes were placed. In the transverse part of the system there was holder of the film substrates. The system was pumped by means of rotary and oil diffusion pumps to a pressure of 10^{-3} Pa. The pressure was measured by ionization and Pirani vacuum gauges. The experimental system was connected with reservoirs with argon and hydrocarbons by means of a set of valves and capillars. The probes were cleaned before every measurement by heating.

Our first experiments were performed in an argon-xylen mixture. The total pressure of the mixture was 50 Pa, the xylen admixture was changed from 2 to 20 %. In this report we give some details about the plasma parameters of these mixtures using the probe method. In Fig. 1 there can be seen the dependence of the axial electric field in the positive column on the admixture of the xylen and on the discharge current. The electric field was determined by help of a two probes system. It is evident that the electric field is an increasing function of the xylen admixture and a decreasing function of the dicharge current.

By means of a single probe diagnostic the electron temperature T_e and the electron density n_e were measured. These two plasma parameters are presented in Fig. 2 in the dependence on the xylen admixture for a discharge current of 20 mA. It can be seen that both plasma parameters first sharply decrease and then increase with the rising xylen admixture, but this charge is not too significant.

Thin polymer films were prepared on the cleaned molybden substrate of a cylindrical shape for two values of bias. The first bias corresponds to the floating potential of the substrate location in the positive

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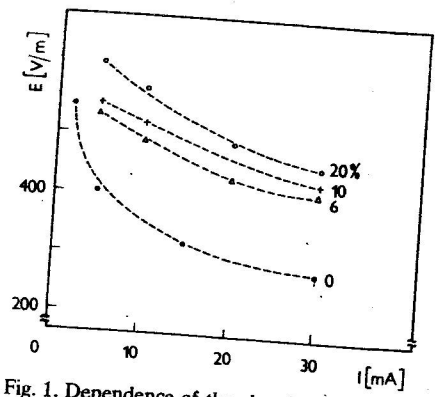

Fig. 1. Dependence of the electric field E on the discharge current and the xylen admixture.

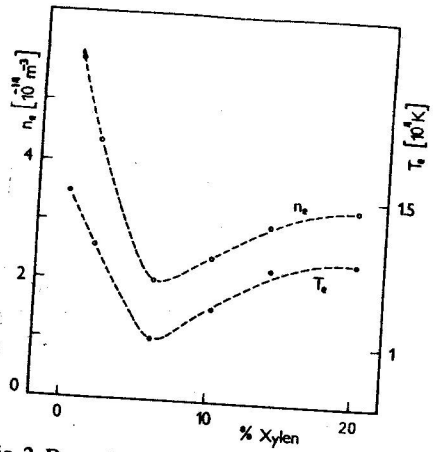

Fig. 2. Dependence of the electron temperature T_e and electron density n_e for $I=20$ mA on the xylen admixture.

column (approximately 300 V), the second one was 400 V. The film thickness was determined according to Klagge [6] from the film resistance (i.e. from the volt-ampere characteristic of the cylindrical substrate) for various deposite times. The thickness of films for 20 % of xylen in the mixture and for the discharge current of 20 mA in dependence on the time for both substrates is denoted in Fig. 3. From this figure it can be seen that the studied process is more effective for a lower bias (curve 1) corresponding to the flowing potential.

Some experiments were performed in pure hexan vapours, but with help of the described method it was not possible to obtain continuous films of a measurable thickness. Only for the case of side discharge on the substrate it was possible to prepare the film of the same properties as films formed on the cathode of the main discharge. In the hexan vapours pyrolytic experiments were performed, too. Two different

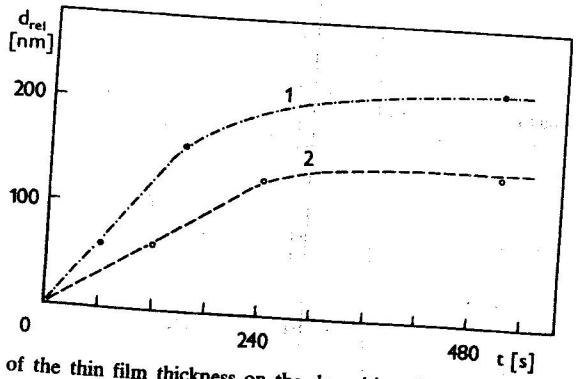

Fig. 3. Dependence of the thin film thickness on the deposition time for a substrate bias of 300 V (flowing potential — curve 1) and 400 V (curve 2).

types of films in dependence on substrate temperature were found. For temperature of up to 2000 °C we obtained films with very good insulating properties, for temperatures ranging from 2100 to 2300 °C the resistance of the obtained films was rather low (the resistance equals 200 Ω). No significant changes of layer properties were observed in experiments when the pyrolysis and the glow discharge were applied simultaneously.

The described experiments suggest that for cyclic hydrocarbons it is possible to prepare films using biased substrates while for simple hydrocarbons this method is not effective enough. In our next experiments we shall study the polymerization of various hydrocarbons as well as the preparation of thin films with defined conductivity.

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