

Metallization and Microstructuring of Insulating Polymers by the PLATO-Technique

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The so-called “PLATO-technique” has been recently developed by Möbius et. al.¹ (Enthone-OMI) and was successfully applied for industrial metallization of ABS and ABS/BC-blends. This technique involves three steps: (i) surface modification (chemical etching), (ii) surface activation (formation of an electronically conducting sulphide surface layer) and (iii) galvanic metallization induced by a local contact of an electronically conducting tip. The metallization occurs by a fast lateral propagation of the deposited metal film, which offers new possibilities for microstructuring of insulating polymer substrates.

In this work the mechanism of surface processes occurring during the modification, activation and metallization stages is investigated by electrochemical measurements and surface analytical techniques such as SEM, AFM and XPS. The possibility for application of the PLATO-technique for metallization of microstructures is also studied. Experiments were performed on the following polymer substrates: ABS, PC, PI, PEEK, FR4. AFM studies give the roughness of surface modification of about 0.1-500nm, corresponding to surface roughness factor $A_{\text{modified}}/A_{\text{unmodified}} = 1.07-1.78$ (A : surface area). XPS results show that the etching during the modification step promotes a roughening and formation of $-\text{COOH}$ and/or $-\text{COH}$ surface groups (Fig.1) leading to a hydrophilic surface. The contributions of roughness and formation of $-\text{COOH}$ ($-\text{COH}$) groups to surface energy for various substrates were studied by contact angle measurements (Fig.2). While surface energy of PC, PI increases mainly due to the formation of $-\text{COOH}$ and $-\text{OH}$ group, surface energy of ABS, FR4 is mainly due to roughness (Fig.2). The role of microcavities for anchoring activation sulfide particles MeS_x in PLATO process is confirmed. The conducting layer MeS_x obtained after activation step is characterized by XPS-sputter profiling. The results show that the layer consists of adsorbed sulfate salts and sulfide layer, which is on surface and anchors in microcavities.

Two approaches were applied for metallization of microstructures (Fig. 3): selective activation (a) and selective surface modification (b). In this work, a selective area on insulating polymer is activated with a simple mask (approach a). Electrochemical deposition of Ni is carried out on activated area. The propagation time of Ni layer during lateral metallization microstructuring depends on the deposition potential and activation degree of surface: $dx/dt=f(U,d_{\text{Cos}})$ (Fig.4). The lateral propagation rate $V_x=dx/dt$ is considerably higher than the vertical growth rate $V_z=dz/dt$ at the first stage of propagation.

References

- 1 A. Möbius, P. Pies, A. Königshofen, *Metalloberfläche* 54(2000)3

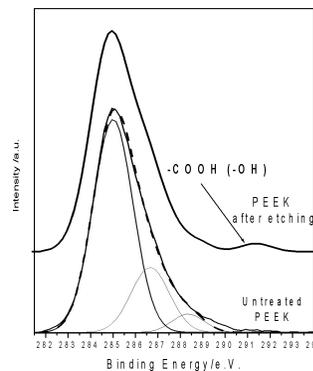


Figure 1: XP-Spectra of PEEK before and after chemical surface modification

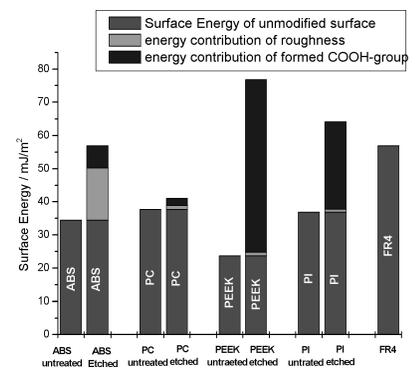


Figure 2: Contribution of roughness and formation of $\text{COOH}(-\text{COH})$ groups to surface energy of different substrates

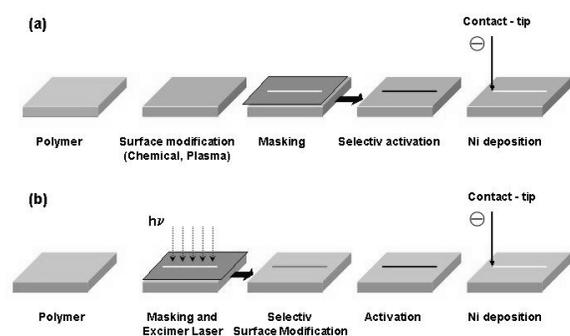


Figure 3 – Two approaches to microstructure with Plato-technique

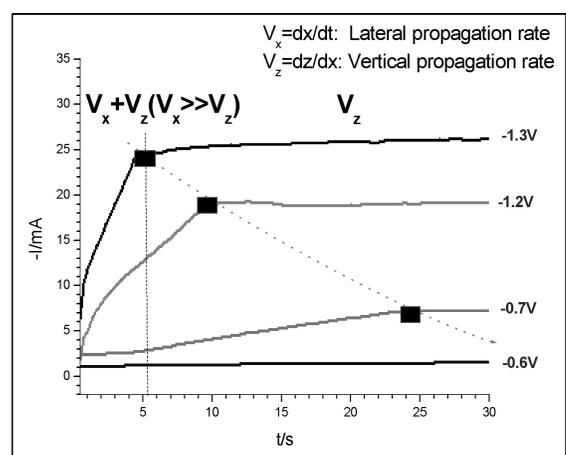


Figure 4 – Influence of potential on galvanic deposition on microstructure