METALLIC FILMS ON POLYMER SUBSTRATES CHARACTERIZED BY IN-SITU SYNCHROTRON X-RAY SCATTERING COUPLED WITH MECHANICAL TESTS

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The new tensile stage TS600 from Anton Paar GmbH was used for *in-situ* synchrotron X-ray scattering investigations on Cu and Ag thin films with the thickness in the range of 50-1000 nm. The films were deposited on uniaxial oriented PET foils of 50 μm thickness. The metal/polymer structures were cyclically strained in the tensile stage and the structural response of the metal film as well as of the polymer were simultaneously monitored using a 2D detector. The experiments were performed at synchrotron sources HASYLAB (beamline A2) and ELETTRA (SAXS beamline).
By performing in-situ SAXS and WAXS experiments on the metal/polymer composites it was possible to determine a variety of structural parameters. In the case of metallic films elastic strains and stresses, flow stresses and the size of coherently diffracting domains were evaluated. For the polymer material, orientation factors and internal strain of crystals and amorphous phase were evaluated from the scattering signal. The parameters were correlated with the actual state of the cyclic tensile experiments. Since the plastic deformation in the metal film occurs at smaller strains then in the polymer, the setup allowed to test the film also in compression. The characterization of the metallic films demonstrated a strong dependence of the flow stresses on the film thickness. For the films below 400 nm thickness, the flow stresses increase dramatically up to few hundreds MPa.
The polymer material was fully elastic in the tested regime. The strain in the amorphous and in the crystalline phase was approximately in the same order of magnitude. No dependence of the metallic film thickness on the mechanical response of the polymer could be assessed.

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