OR0505

Adhesive Strength and Failure Pattern of Coatings on Polymers and Glass - Centrifugal Adhesion Testing (CAT) - towards the Simulation of Adhesion

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Adhesion is a key functionality for any kind of coating/substrate system. For optical applications, metallic and dielectric coatings are of major interest, in particular for crucial materials such as silver and gold on glass or metals and dielectrics on polymers. Adhesive strength is defined as the tensile force per area upon delamination. There are only two tensile testing procedures available, the single-sample pull-off test in a tensile testing machine and the multiple-sample test within a centrifuge. Both tests require bonded test stamps on top of the coating. After testing, a microscopic inspection is required in order to determine the failure pattern according to ISO 10365 such as adhesive failure (AF), delamination failure (DF), and cohesive failure (CF). There are remarkable effects of the substrate thickness and the plasto-elastic properties of the substrate on the measured adhesive strength. This fact is in general unavoidable as adhesion is a system property and testing of adhesion is a destructive stress test of the entire coating/substrate system. Various material combinations such as Al on polypropylene (PP), SiO_2 on CR39 polymer, protected layers of Au and Ag on glass have been investigated. Delamination failure (DF) could be divided into DF-R (delamination of metallic reflector) and DF-D (delamination of dielectric protection). Plasto-elastic properties and different thicknesses of the substrate yield to an uneven bending of these substrates during the test. As a result, unavoidable material-induced shear forces are produced, e.g. in dependence on substrate thickness, which is simulated by means of “inverse” the filmdoctor software usually applied to compressive stress conditions. From the first results this might give access to the adhesive strength as calculated independent of the substrate thickness.

Keywords
adhesive strength
multiple-sample testing
plasto-elastic properties
thickness dependence
simulation of adhesion