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Adhesion of Coatings vs. Strength of Composite Materials – A Review of Applications Evaluated by Centrifugal Adhesion Testing (CAT)

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Sufficient adhesion/tensile strength are basic requirements for any coating/ composite material. For coatings, adhesive strength in N/mm^2 is of major interest for various applications such as decorative and water-repellent coatings on wood (paints and varnishes), optical coatings on glass and polymers (reflectors and filters), electrical coatings on semiconductors, glass and polymers (conducting and bondable layers), mechanical coatings on metals and polymers (wear-reduction, scratch-resistance) and adhesion-promoting layers. For composite materials, tensile strength in N/mm^2 is also a key quantity for carbon fiber reinforced composites (CFC), laminates and adhesive-bonded joints. Centrifugal adhesion testing (CAT) transfers the single-sample tensile test from a tensile or universal testing machine into an analytical centrifuge as multiple-sample test of up to eight test pieces. The one-sided sample support instead of a two-sided sample clamping and the absence of mounting- and testing-correlated shear forces provides fast and reliable results both for adhesive strength and bonding strength by means of bonded test stamps. For bonding strength, the evaluation of failure pattern from 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). Hence, one test run by CAT-technology provides either statistics or ranking of up to eight samples at once. For adhesive strength of coatings, a variety of examples is discussed such as ALD-Al_20_3 layers as adhesion promoters, evaporated Ag-layers on N-BK7 glass, sputtered Cr- and Al-layers on Borofloat 33 glass, evaporated Au-films on N-BK7 glass and sputtered SiO_2 -layers on CR39 Polymer. Provided adhesive or bonding strength are high enough, the substrate or the joining part may also fail.

Keywords
adhesive strength
pull-off test
centrifugal adhesion testing
failure pattern