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## **Quantitative Adhesion Testing of PVD-Coatings by means of Centrifuge Technology**

Uwe Beck<sup>1</sup>, Georg Reiners<sup>1</sup>, Matthias Weise<sup>1</sup>, Dietmar Lerche<sup>2</sup>, Uwe Rietz<sup>2</sup>, Hansjoerg Niederwald<sup>3</sup>

<sup>1</sup>BAM, Berlin, Germany <sup>2</sup>LUM GmbH, Berlin, Germany <sup>3</sup>ZEISS, Oberkochen, Germany

uwe.beck@bam.de

Adhesion testing of coatings is of fundamental interest for quality assurance and still a challenge regarding reliable quantitative results. Almost all tests are qualitative rather than quantitative. Except for the pull-off test, testing is not directly correlated to the adhesive strength in terms of force per area.

For PVD-coatings on glass and polymers, standardized tests apply, i.e. abrasion tests (cheese cloth or eraser test) and adhesion tests (tape/peel or cross-hatch test) with different degrees of severity. Instead of the adhesive strength, all these tests provide only qualitative information on the abrasion or adhesion resistance against the cheese cloth, eraser, tape/peel or cross-hatch load. The adhesive strength as physical quantity is not measured and tests are hence not comparable.

In this respect, the patented centrifuge test is a breakthrough in adhesion testing. It has manifold advantages. First, it can be easily run as multiple-sample test. Second, it is much easier and faster than any other test. Third, adhesive strength is measured in absolute numbers (N/mm<sup>2</sup>). Fourth, compared to the pull-off test, it is advantageous that sample clamping is one-sided instead of two-sided. Moreover, the centrifuge technology enables tests under defined climates or hazardous environments as well as versatile test conditions such as alternating loads important to fatigue testing. The desk-top fracture analyser LUMiFrac made by L.U.M. may analyse simultaneously up to eight different samples. For layers provided by Zeiss and BAM, conventional tests are discussed and compared in detail with the centrifuge test. It could be shown that the centrifuge test has remarkable advantages with regard to accuracy, precision and reproducibility. In addition, the centrifuge test was able to discriminate the adhesive strength for coating/substrate systems until failure that did not fail in any of the standardized tests. Finally, further activities on the standardization of the centrifuge test are briefly discussed.

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### **Keywords**

adhesion testing

centrifuge technology

coatings on glass and polymers