ABSTRACT

Micro-scratch testing of Polymers

L. Andena1, P. Guzmán García Lascurain1, S. Tagliabue1, L. De Noni1, F. Rosi1, D. Comelli1
1Politecnico di Milano, Milano, 20133, Italy.

Scratch damage can severely affect polymeric products, not only by deteriorating their aesthetic appearance but also by impairing their functionality and, in extreme cases, compromising their structural integrity. From an application-oriented perspective, the prediction of scratch visibility remains an open and challenging research topic. Although several approaches aimed at providing reliable and objective optical measurements of scratch resistance have been proposed in the literature, achieving a close correlation with human visual perception is still difficult.
By contrast, the mechanical description of scratching in polymers is a more established field. Scratching is a highly complex contact phenomenon involving friction, strongly non-linear stress and strain fields, extensive visco-plastic deformation and, in some cases, fracture. In previous work, we proposed a methodology to define a mechanical resistance parameter, identified as scratch hardness [1], and demonstrated its strong correlation with the bulk mechanical properties of polymeric materials, in particular with the rate-dependent compressive yield stress.
This connection enables micro-scratching to be exploited as a surface-sensitive probing technique, capable of providing fundamental information on the mechanical properties of the material in regions where critical phenomena are likely to occur. Such phenomena include degradation induced by exposure to physical or chemical agents (e.g. solar radiation, oxidizing species), which typically initiates within a thin surface layer. In these cases, the sensitivity of conventional bulk mechanical testing techniques may be insufficient to adequately capture the early stages of material degradation.
Selected case studies are presented in which micro-scratching, combined with complementary analytical techniques, is used to investigate degradation and ageing phenomena in applications related to sports equipment, automotive components and cultural heritage materials.

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