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ADVANCED SURFACE MECHANICAL TESTING OF MATERIALS FOR MEDICAL APPLICATIONS

Ethel Poiré
EP Laboratories, Inc.
Irvine CA, USA

This paper presents an overview of two advanced surface mechanical testing techniques: the instrumented indentation testing and the single point scratch testing techniques. Both can be used for studying bulk or thick materials, they are however powerful tools in the cases of thin layers and small features, elastic materials and surfaces with poor optical contrast. Most samples can be tested "as is" or with minimal preparation.

INSTRUMENTED INDENTATION TESTING

Instrumented indentation testing (IIT) is a mechanical test during which an indenter of known shape and elastic properties is slowly forced into the surface of a test specimen and withdrawn. Throughout the entire process, the force applied to the indenter and the displacement of the indenter's tip into the surface of the material are recorded at specific time intervals such that a force-displacement curve can be generated[1].

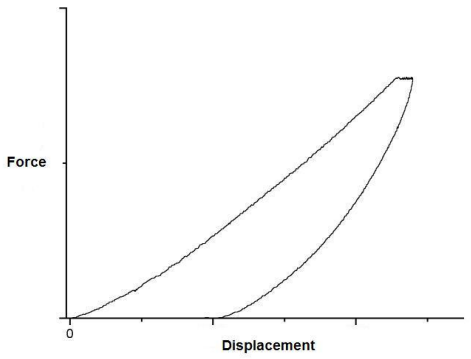

FIGURE 1. FORCE-DISPLACEMENT CURVE

The strength of IIT lies in the fact that properties can be determined without visualizing the residual imprint left on the tested surface. It therefore has the advantage of allowing to accurately measure mechanical properties of very thin films, small features or areas that could not be tested using conventional techniques. Materials that break or crack under too much load can also be safely tested[2]. One single indentation can provide the hardness, the elastic modulus and the creep through the analysis of the force-displacement curve. The entire test sequence is computer controlled; It can however be configured in unlimited ways by setting the test parameters (ex: maximum applied load, loading and un-loading rates, pause at maximum load, number of test cycles).

The technique, being very precise and reliable, can distinguish specimens that have differences in properties smaller than 1%. It has been shown that IIT can successfully be used to determine changes in hardness and elastic modulus of porous materials with very poor optical contrast such as tablets; in which case, no imprint can be observed once the indentation testing is completed[3].

The force-displacement curve can also be used to monitor uniformity of physical properties in function of depth.

SINGLE POINT SCRATCH TESTING

In single point scratch testing, a diamond stylus is drawn across the surface of a test specimen at a constant speed and a defined normal force (constant or progressively increasing) for a defined distance. The damage along the scratch track is microscopically assessed as a function of the applied force. Specific levels of progressive damage are associated with increasing normal stylus forces.[4]

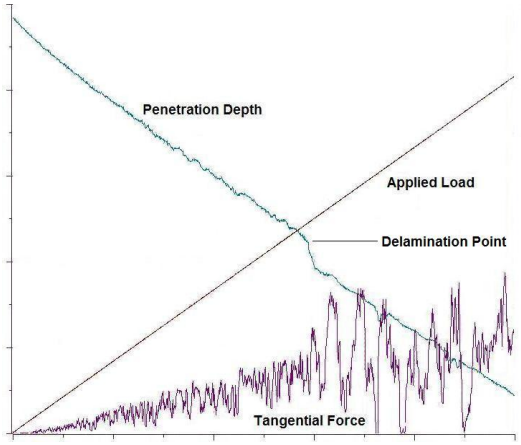

FIGURE 2. SCRATCH TESTING CURVE (PROGRESSIVE INCREASING LOAD)

The technique is commonly used for evaluating the scratch resistance of coated and uncoated specimens, and for measuring the adhesion of coatings[5,6]. It can easily be used for cracking studies and for comparing hardness and permanent deformation of materials. The test is computer controlled; the load, loading rate, scratch length and speed and the indenter are set by the operator.

The fact that the tangential force is being measured during a test allows to obtain the coefficient of friction for a given test configuration. The values of coefficient of friction without wear can be obtained by performing a scratch at a constant load using a nanoscratching instrument[7,8].

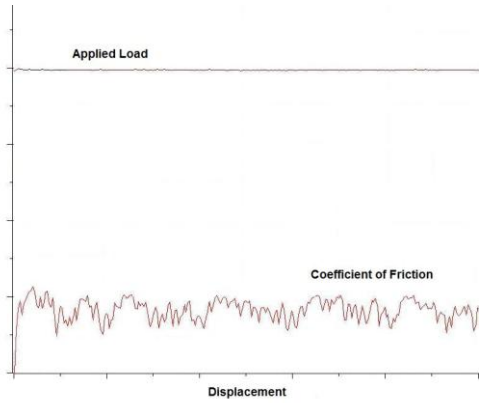

FIGURE 3. SCRATCH TESTING CURVE (CONSTANT LOAD)

The instrument's capabilities allow for obtaining the friction value distribution over lengths from 0.01 to 50mm, when conventional techniques only provide the average value.

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3. *The Use of Instrumented Indentation to Measure Hardness and Elastic Properties of Tablets* E. Poiré. Biomaterials 2005, Memphis TN, April 27-30, 2005
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