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Steps towards a mechanical modeling of layered systems

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Abstract

Up to now the search for suitable film substrate combinations with respect to mechanical applications is mainly based on empirical approaches using results of hardness, scratch, wear or other tests. It is desirable to cut down this time consuming process by a higher degree of modeling. Steps towards this aim are presented using a novel methodology for the evaluation of the response of coated substrates to mechanical contact. This approach is based on the combination of a recently developed theoretical method (the method of image loads) and high-accuracy indentation experiments using spherical indenters. For different film substrate combinations it is shown how accurate and reliable values of mechanical film parameters like Young's modulus and yield strength can be obtained, even for films below 100 nm thickness. Then the theoretical method is used for the calculation of critical loads to failure of film-substrate combinations in dependence on the radius of the counterpart. It is shown how the addition of an intermediate layer can improve the whole compound and which properties it should have. Finally the influence of an additional tangential load due to friction in a sliding motion on the stress fields is investigated. The conventional scratch test is discussed in the light of the latter results.

Keywords: Mechanical modeling; Scratch testing; Hardness; Young's modulus