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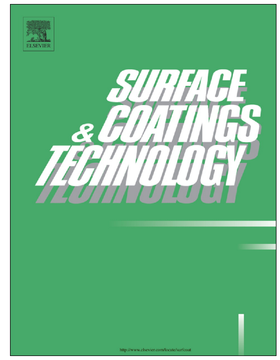

High resolution lateral force-displacement measurements as a tool for the determination of lateral contact stiffness and Poisson's ratio

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High resolution lateral force-displacement measurements as a tool for the determination of lateral contact stiffness and Poisson's ratio

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Abstract

A Lateral Force Unit (LFU) as a second measuring head for nanoindenters is now available as a commercial tool with the necessary accuracy to investigate the elastic contact between a sphere and a flat surface with sub-nanometer resolution. The combination of normal and lateral load-displacement measurements at one and the same sample position gives two independent measurement results and can therefore be used to extract beside Young's modulus a second elastic constant. This can be shear modulus or Poisson's ratio for elastically isotropic materials. To realize that, it is necessary to determine all necessary corrections with high precision. This comprises normal and lateral instrument compliance, indenter area function, spring constant of the holding springs of the LFU and the surface slope. Two algorithms were developed and tested for the determination of the Poisson's ratio from fully elastic measurements with a spherical indenter. One is using the ratio of normal and lateral contact stiffness and the other the curvature of the lateral load-displacement curve at the turning points and the transition from sticking to sliding friction. By measuring six different materials it was shown that the ratio of normal and lateral contact stiffness results in relatively large errors for the Poisson's ratio of up to 50% against literature data while the other method had only an error (1σ) between 6% and 20%. The last method is restricted to hard and smooth materials to enable measurements in fully elastic regime but it can also be applied to coatings if they are about 2.5 - 4 times ticker than the contact radius during the measurement. This is