

THE CALIBRATION OF NANOINDENTERS REVISITED

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Key Words: force calibration, displacement calibration, area function, instrument compliance, tip rounding

The calibration of nanoindenters is an indispensable duty for the measurement of correct hardness and modulus in instrumented indentation. This includes first the calibration of the measuring heads regarding force and displacement and second the calibration of the instrument compliance and the area function of the tip. All the calibration requirements are described in the standard ISO 14577.

In a first step it will be checked how the requirements of the standard for force and displacement calibration can be realized in practice. In a second step the calibration of instrument compliance and area function are considered. The area function results should not depend on the used reference material and on the calibration method (direct or indirect). This is investigated for 18 different Berkovich tips. A novel calibration method is proposed that confirms the material independence of the area function and gives a force dependent instrument compliance function. An agreement between direct and indirect calibration could only be achieved by considering a radial displacement correction. Further it is shown that the transition range from a spherical cap to the correct face angle of the pyramid can extend to a depth of more than 250 nm. A better parameter for the indenter than the tip radius is the offset of the contact radius to the radius of an ideal tip in a depth where the correct face angle is reached.

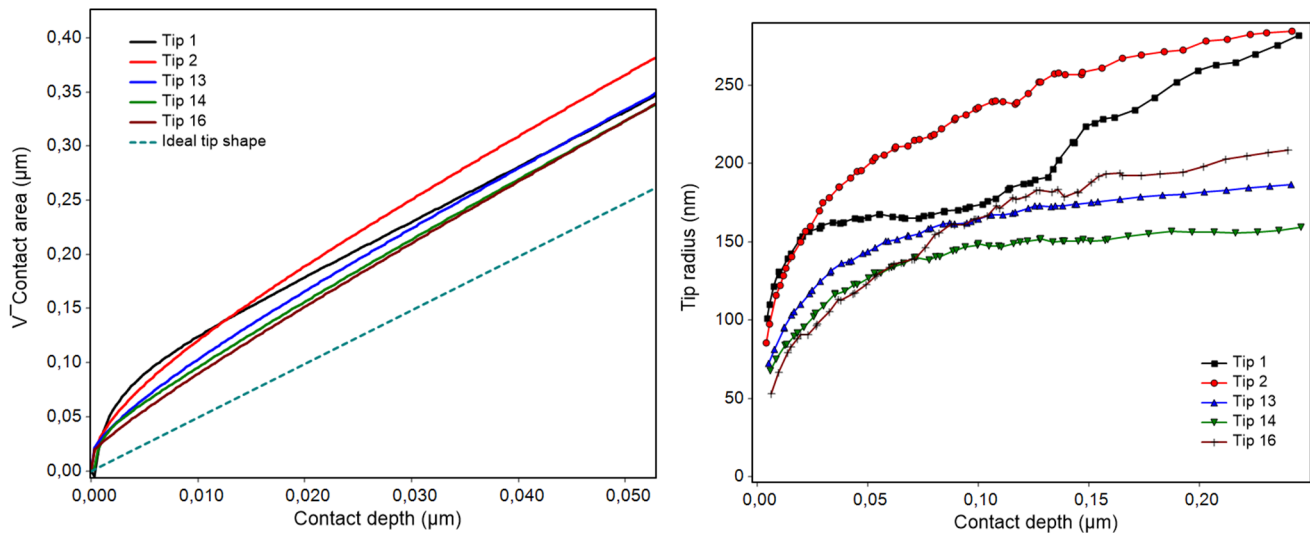


Figure 1: Left: Section of the area functions for the first 50 nm of contact depth and for 5 different Berkovich tips; Right: Effective tip radius as function of contact depth.