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Basic physics disproves the obligatory ISO-14577 standards: a dilemma for all indentation mechanics

Most mechanical properties of materials are deduced from hardness and elastic modulus. The most used and versatile technique for their detection is indentation mostly with pyramidal/conical diamond tips. Obligatory ISO-14577 defines and iterates hardness (H_{ISO}) and elastic modulus ($E_{r\text{-}ISO}$) with respect to projected contact area (A_{hc}= const h_c^2), but with violation of the basic energy law, which therefore triply violates basic physics. Still applied very high-load indentation techniques such as Vickers, Knoop, Brinell, Rockwell, and Shore hardness are even more empiric and they include at least the same violations. Nevertheless, they are still widely accepted without trying to develop a sound physical foundation. Thus, the normal force (F_N) is not proportional with *h2*, but with $h^{3/2}$, as is physically founded and experimentally confirmed. The pressure has long been used for the elastic modulus determinations though. It does not help that the very high-force techniques rely on the diameters of the impression surface such as Vickers, Knoop, Brinell, or that Rockwell and Shore measure depths. Problems with cracks are not reported, but different load ranges are distinguished and empirical inter-conversion formulas used. The physically valid Hphys can now be obtained by linear regression of the loading curve's $F_N = k\, h^{3/2}$ plots without the three flaws Er-phys requires energy correction and additionally stiffness dF_{max}/d_h, omitting iterations with simplest arithmetic. It is valid for all types of materials and all instrumental depth sensing techniques. Indentation moduli are not "Young's moduli" and should be directly calculated but not iterated with up to 11 free parameters. The dilemma of the ISO standards against physics and thus the woldwide "enforced" calculation of wrong mechanical properties is detrimental, producing very large size-dependend errors.The physical correctness must be installed instead for the sake of daily life security. Examples will be discussed. ISO appears slow in changing its standards for complying with physics. They are continuously asked to release an urgent caveat, telling that ISO-14577 will be subject to change for the physical reasons.

Biography

Prof. Dr. Gerd Kaupp studied chemistry at the University of Würzburg, Germany and had postdoctoral appointments at Ames, Iowa, Lausanne, and Freiburg i. Br, where he became appointed as associate professor. From there he was appointed full professorship at the University of Oldenburg in 1982. He guided a successful research group with various projects and cooperation with numerous industries and worldwide academic research groups. He served as guest professor for several international universities. Prof. Kaupp is now a retired member at the University of Oldenburg and pursues his scientific interests also with consulting. His expertise is in chemical kinetics, laser photochemistry, waste-free benign syntheses and productions, solid-state chemistry, reactive milling, mechanochemistry, atomic force microscopy AFM, scanning near-field optical microscopy SNOM, nanoscratching, nanoindentation, standardization in nanomechanics, and bionics. He is keynote speaker in these fields, published numerous scientific papers and books and is inventor of patents in solid-state and environmental chemistry.

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