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Gerd Kaupp

University of Oldenburg, Germany

ISO violates the first energy law including hardness/elasticity standards from indentations: What can be done?

One of the most used and versatile techniques for (nano)mechanics is the indentation with pyramidal/conical diamond tips. ISO-14577 defines and iterates hardness (H_{ISO}) and elastic modulus (E_{rISO}) with respect to projected contact area (A_{hc}= const·h_c^2) with (nearly) legal character. This has been widely accepted since half a century, as it seems to support the Sneddon normal force (F_N) proportionality with h^2 hypothesis, which however has been disproved experimentally. And the proportionality with $h^{3/2}$ is physically founded. The wrong exponent 2 on h has not only been used for the unphysical deduction of most mechanical parameters but, unlike F_N=$kh^{3/2}$ plots since 1990 (where k is the material's penetration resistance), it cannot detect frequent phase-transformation in the loading curve, so that numerous unloading curve iterations from F_{Nmax} do not characterize pristine material. Even worse, these ISO standards violate the first energy law, because the concomitant shear-force work and thus not all of F_{Nmax} "arrives" at the projected area (published since 2012). The physically valid H_{PHYS} can now be obtained by linear regression of the loading curve's F_N=$kh^{3/2}$ plots (E_{rPHYS} requires additionally stiffness) and depth correction, omitting iterations with simplest arithmetic. It is thus valid for all types of materials and all instrumental indentation techniques. The dilemma of the ISO standards against physics and thus the enforced calculation of wrong mechanical properties is detrimental, producing very large errors (exponential size dependence!) and liability problems in case of materials failure. Textbooks and instrument software must be rewritten, ISO-14577, a NIST tutorial and numerous publications must be retracted. The physical correctness must be installed for the sake of daily life security. Examples will be discussed. ISO appears slow in changing its standards for complying with physics. They are asked to release an urgent caveat, telling that ISO-14577 will be subject to redefinitions for physical reasons.

Biography

Gerd Kaupp has studied Chemistry at the University of Würzburg, Germany and had Post-doctoral appointments at Ames, Iowa, Lausanne, and Freiburg i. Br, where he became appointed as Associate Professor. From there, he was appointed as full Professor 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 has served as Guest Professor for three international universities. He 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 serving as keynote speaker in these fields, published numerous scientific papers and books and is inventor of patents in solid-state and environmental chemistry.

gerd.kaupp@uni-oldenburg.de

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