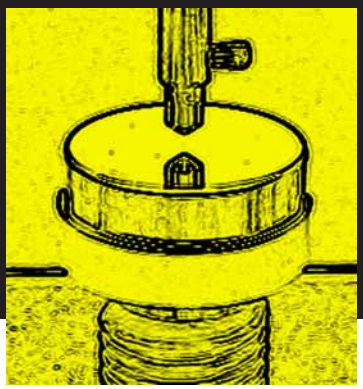
Hardness Standardization

Objective

Our objective is to standardize and improve hardness measurement both in the U.S. and internationally. NIST is the U.S. National Metrology Institute (NMI) for hardness, and as such, is responsible for traceability in hardness measurements.



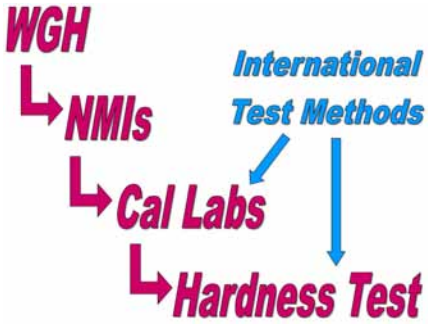
Impact and Customers

- Hardness is the most commonly used industrial test for quality control and acceptance testing of metals and metallic products.
- Of over 12 000 ASTM standards, hardness test method standards are among the most downloaded.
- NIST produces a variety of hardness Standard Reference Materials (SRMs) for industry.
- The NIST hardness standardization project impacts customers at all levels. Impact is evidenced through the interactions with the International Bureau of Weights and Measures (BIPM) during the development of international test method standards, by those performing hardness research, by those involved in laboratory accreditation, through the calibration of reference standards, by those involved in industrial hardness measurements, and through organized hardness conferences and workshops.

BIPM
ASTM INTERNATIONAL Standards Worldwide
NVLAP
IMEKO
ISO International Organization for Standardization

Approach

As the U.S. NMI for hardness, NIST's role is to improve hardness measurement at all levels of traceability. The hardness traceability structure begins with the Working Group on Hardness (WGH) under the umbrella of the BIPM. NIST represents the U.S. in this committee by providing input in the development of the hardness definitions. The hardness definitions are the standard to which NMIs perform hardness measurements, although differences still exist between NMIs. NIST participates in worldwide comparisons between NMIs, and interacts bilaterally with the standardizing laboratories of other countries.



NIST transfers the U.S. national hardness scales to industry via hardness reference block SRMs sold primarily to secondary calibration laboratories, and takes additional steps to ensure that the hardness SRMs are used effectively, through participation in laboratory accreditations. Almost all industrial hardness measurements, whether made at calibration laboratories or industrial facilities, follow the test method procedures developed by Standard Development Organizations (SDOs) such as ASTM International and the International Organization for Standardization (ISO). Through our participation and leadership in these hardness committees, NIST is able to communicate its expertise, research and experience.

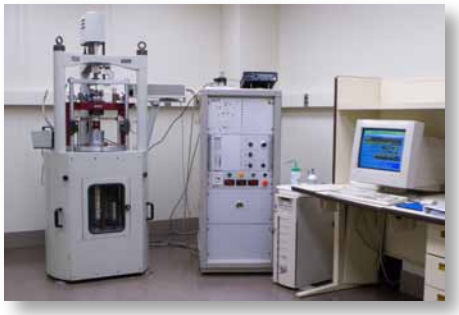
METALS

Accomplishments

The National Institute of Standards and Technology, formerly the National Bureau of Standards (NBS), has been involved with the measurement of hardness for decades. In 1937, for example, Frederick Knoop developed the Knoop hardness test at NBS, an important microindentation test still used today. However, an expansive NIST effort in hardness standardization didn't begin until the mid 1990's with the initiation of a Rockwell hardness standardization project, which had been requested by ASTM. The importance of this project increased with the creation of the WGH within the Consultative Committee on Mass and Related Quantities (CCM) of the BIPM, acknowledging hardness as one of the world's important measurement quantities.

The hardness standardization project has had a significant impact on hardness testing within the U.S. For example, in 1998, the U.S. Rockwell C scale (HRC), used for testing steel, was corrected to bring it in line with the rest of the world as a result of the release of SRMs for the HRC scale.

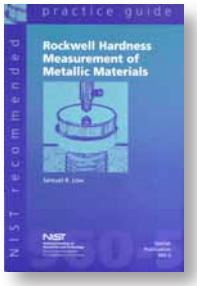
The development of HRC SRMs was made possible due to our collaboration with the NIST Precision Engineering Division's facility to characterize indenters.



NIST Rockwell Standardizing Machine

In 2001, NIST published a Recommended Practice Guide on Rockwell Hardness Measurement. To date, over 7000 copies have been requested and distributed, many through hardness machine and test block manufacturers.

Today, the NIST hardness standardization effort includes participation in the international effort within the WGH to better define hardness tests and to reduce measurement differences between NMIs.



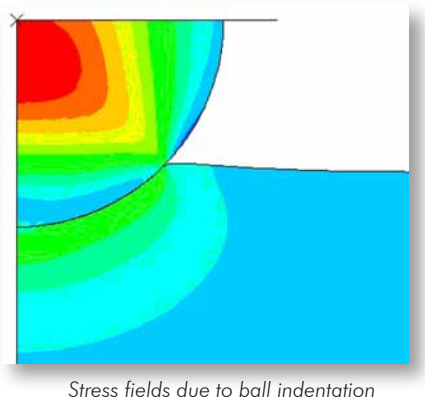
NIST Recommended Practice Guide SP-960-5

A revision of the definition of the Brinell hardness test is now underway, which will define absolute values for test parameters, rather than the current situation of having allowable tolerance ranges. NIST is also helping to prepare worldwide Key Comparisons between NMIs for the Rockwell C scale and the methods used by NMIs for characterizing Rockwell diamond indenters.

NIST participates in the development of international hardness test method standards at ASTM and ISO. As Chair of the ASTM hardness committee, NIST is currently leading the task of revising two ASTM Vickers hardness standards (E384 microindentation & E92 heavy-load Vickers), and consolidating them into a single document. As the Head of Delegation for the US delegation to the ISO hardness committee, NIST is leading the revision of the ISO Rockwell hardness standard (ISO 6508).

Currently, NIST produces hardness test blocks as SRMs for a variety of Vickers, Knoop and Rockwell hardness scales and hardness levels. The SRMs are used by industry to calibrate their hardness machines traceable to NIST. Current new efforts involve researching improved materials for Rockwell B scale reference standards, and the development of a new Rockwell diamond indenter SRM and an SRM for the calibration of Brinell hardness indentation measuring systems.

NIST's research efforts in recent years have included investigations of the influence of important parameters (e.g., force errors, indenter shape, loading rates, etc.) for each of the hardness scales. NIST's modeling of indentation is helping international efforts to define the true edge of a Brinell hardness indentation, and was instrumental in ASTM's decision to specify tungsten carbide as the standard Rockwell ball indenter.



Stress fields due to ball indentation

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Publications

Low SR *Rockwell Hardness Measurement of Metallic Materials* NIST Recommended Practice Guide, SP-960-5 (2001)

Ma L, Low SR and Fink J *Effects of Steel and Tungsten Carbide Ball Indenters on Rockwell Hardness Measurements* Journal of Testing and Evaluation, 34(3): 187 (2006)

Song JF and Low SR *Geometrical Form Error of Rockwell Diamond Indenters* Proceedings of HARDMEKO 2007, Tsukuba, Japan (2007)

Low SR and Fink J *Recent Changes and Additions to the Hardness Test Methods Developed and Published by ASTM-International* Proceedings of HARDMEKO 2007, Tsukuba, Japan (2007)