Shore A hardness measurement of elastomer finished units – even for smallest parts– independent of form and wall thickness

The new Nano-testing method permits the measurement of hardness according to Shore A (Shore D) even of very small parts of most different geometry applying a measuring method, which in its physical load parameters is identical with the Shore A (Shore D) - measurement but of a reduced scale and thus leads to standard measurements of identical results.
As the preloading of the test needle was waived, extremely soft materials can be controlled with the Shore A characteristic. Measurable hardness ranges from -5 to +100 Shore A, thereby the entire elastomer hardness range is presentable in one characteristic line. Since the specimen configuration does not influence the testing, a very high measuring accuracy (± 0.2 ShA) is given.
Standard measurement on any geometry of materials which have a wall thickness of 0.5 up to 0.6 mm can be made with the Shore A nano procedure.
Comparative measurements of the hardness with a feedback to Shore A are possible for a wall thickness beginning with 50 µm.
The sample positioning is supported by a laser projection.

The shore A-hardness is a substantial characteristic of flexible materials, it determines the area of application of the products and represents important test characteristics. The declining load characteristic and geometry of the metering needle permits measurements contrary to other hardness testing methods, thus covering practically the entire hardness range of rubber/elastomer items. The standard Shore measurement presupposes at present according to DIN 53505/DIN ISO 868 a minimum thickness from 4 to 6 mm and an even bearing surface of 18 mm in diameter. This permits only in rare cases the measurement on manufactured construction units. The determination of the hardness is made with purpose-built test plates.
Because of this newly developed measuring procedure the measurement of hardness of finished products of any shape, beginning with a wall thickness 0.5 mm (and/or 50 µm) is problem-free feasible. The measured values are independent of size and form of the parts. They can be safely tested immediately after production, aged, or after a longer use. The effects of processing conditions in the manufacturing process (injection speed, vulcanisation temperature, annealing etc) are immediately visible and/or correctable. Because of the miniaturized Shore measurement the evaluation of the hardness distribution and/or the product homogeneity is problem-free possible by measuring a unit at different points. The definition of the measuring points is effected via a special laser projection and permits a simple and exact positioning of the construction units which have to be measured. The high measuring accuracy of ±0.2 Shore A-points after the nano-testing method permits a safe product evaluation.

What is the hardness measurement after Shore A?
Basically, the hardness measurement is a simple physical procedure. A needle that has a defined geometry is pressed at a given force and/or force function into a material surface and/or a material cut surface and then the reaction concerning penetration depth depending on time is measured. Standards, such as DIN 53505 define geometry (fig. 4) as well as the test sequence. The Shore A specification describes a needle with a conical tip and with a decreasing penetration depth an increasing penetration force. This combination permits to measure a very wide hardness range since at soft products – due to the declining force characteristic only a small force takes effect, whereas the cross-section area increases because of the conical form of the needle. On hard materials, due to the small penetration depth a strong force works simultaneously because of the small needle cross section. As the measurement works in form of a physical load of a defined pressure onto the material to be measured, the measuring unit if there is a comparable load characteristic can be geometrically reduced.

• Q-TEC GmbH
Bergstraße 2
D-84367 Zeilarn
Telefon: (0 85 72) 96 02 -0
Telefax: (0 85 72) 96 02-88
Internet: www.q-tec-gmbh.de
E-Mail: info@q-tec-gmbh.de

Shore A nano

The aim was to develop a device to check the hardness of finished parts in a simple way, regardless of their size and geometry. Therefore the load of the needle of standard Shore A was reduced linearly by factor 10 (Fig. 3). In order to get Shore A identical load conditions, and thus comparable test results, the pressure had to be adjusted due to the penetration depth of the standard measurement. The pressure load is calculated according to function $p = F / (d^2\pi / 4)$. I.e. the load characteristic is reduced by the factor $10^2 = 100$ in comparison to standard measurements. The forming of an indentation on a unit is therefore, in a reduced scale, geometrically identical to standard measurements. (Fig.1)
With a special load unit the force, depending on the penetration depth into the measured point of the specimen, is executed and the penetration depth in relation to the surrounding surface is measured. The standard Shore measurement needs in order to measure hardness a bearing surface for the positioning of the needle and for the determination of the penetration depth in relation to the surface.
The separation of the load unit (metering needle) and the support plate as a separate measuring sensor allows an independent control of the surface as to the position of needle. Therefore an even surface for the positioning of the needle is not necessary. The only requirement for the correct measurement is the vertical touchdown of the needle on the product surface to be measured otherwise the active penetration surface is not conform to specifications. As the needle's diameter is only 0.079 mm, crooked surfaces or radii play no role (Fig. 2).

Essential is the accurate positioning of the test specimen measuring point. For this purpose a laser with crosshairs was integrated which easily allows a very precise alignment on the removable slide. The measuring procedure is fully automated and is controlled by an embedded PC system. The slide technique allows measurements of items of identical geometry in a very simple and safe positioning by adhesive bonding of positioning aids on the carrier.

The Shore A hardness measurement scale according to DIN ranges from 0 to 100 Shore A. Measured is the hardness within the range of 10 to 95 Shore A. Because of the pre-loading of the needle – for the standard equipment to Zero Shore A- a useful measurement is only possible from approx. 10 Shore A going.
In contrast, the new load unit of the Shore A nano device is not preloaded and thus allows measurements even on very soft products without changing to another measurement procedure such as Shore 00. The pre-loading range with values smaller 0 Shore A, is used for very soft materials and permits comparisons on the Shore A scale by extending the curve to values smaller than zero. The measurement range comprises -5 to +100 Shore A.

Accuracy and comparability

The results are concerning Shore A values of the standard methods according to DIN, ISO, ASTM and JIS for homogeneous materials absolutely comparable. This test is identical with the specific physical load parameter of the Shore A measurement. The new measuring method achieves a very high measuring and repetition accuracy as unfavourable specimen properties such as shape and geometrical deviations are of no influence. Comparative measurements have shown that the miniaturization of the geometry to a needle tip diameter of 0.079 mm do not influence measuring results of different products. Measurable are also differences of inhomogeneous parts, which partly show considerable differences of hardness across the cross section. The nano measurement method brings measurement accuracies of ± 0.2 Shore A, throughout the entire range, that is significantly beyond requirements for standard equipments.

The new measuring method offers the possibility of a reduction of the maximum penetration depth and force components up to factor 10 and offers the possibility to determine the hardness of a wall and coating thickness as small as 50 microns The correlation with the Shore A hardness can be determined by measuring parts of a known Shore A hardness with a reduced penetration depth.

The test equipment covers metrological the entire hardness range of rubber/elastomer materials and allows measurements of differently shaped parts or composite materials. The result is a characteristic material parameter independent of geometry and size.

• Q-TEC GmbH
Bergstraße 2
D-84367 Zeilarn
Telefon: (0 85 72) 96 02 -0
Telefax: (0 85 72) 96 02-88
Internet: www.q-tec-gmbh.de
E-Mail: info@q-tec-gmbh.de