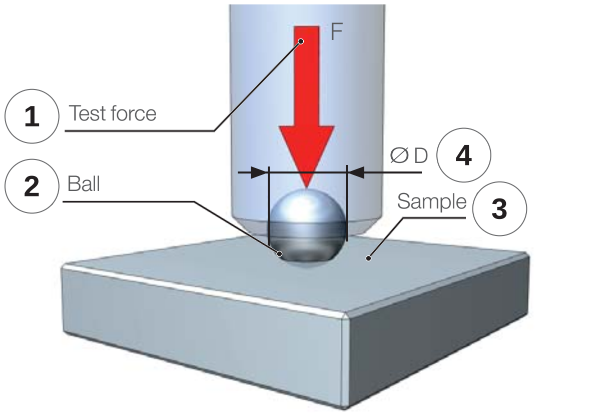
METAL HARDNESS TESTING

Hardness Test Methods

Hardness is the resistance of a material to the penetration of a test specimen.

Brinell Hardness Test

During a Brinell hardness test, a carbide ball **(1)** is pressed into the sample **(3)** with a test force **(2)** and the diameter D **(4)** of the resulting indentation of the ball is measured.
The Brinell hardness is calculated from the test force F and the surface of the ball indentation. In practice, the Brinell hardness value is read from tables for a specific test force F and the indentation diameter D or is calculated by a computer.



Brinell hardness test

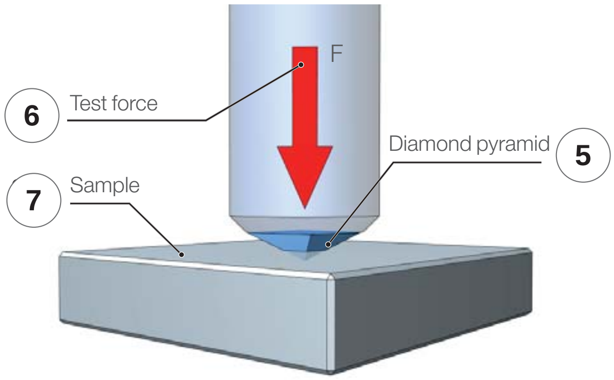
Vickers Hardness Test

During a Vickers hardness test, the tip of a square-base pyramid-shaped diamond **(5)** is pressed into the sample **(7)** with a test force F **(6)** and the diagonals of the resulting pyramid indentation are measured.
The Vickers hardness HV is calculated from the test force F (in Newton) and the length of the middle diagonal d (in mm) according to the formula:

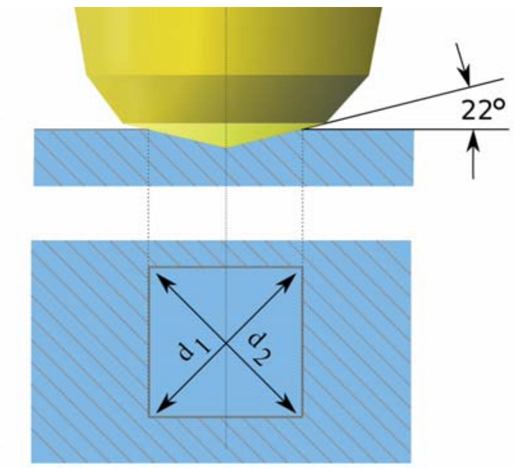
$$HV = 0{,}189 * F / d^2; \quad d = (d_1 + d_2) / 2$$

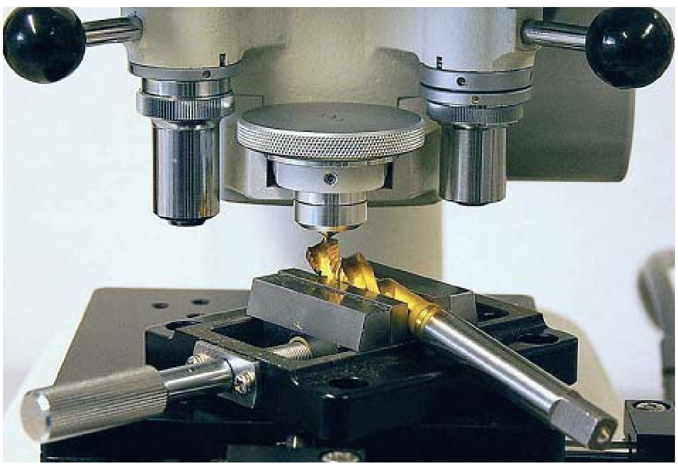
There is only one indenter for hard and soft materials.

<u>Example of a Vickers hardness specification</u>: 210HV50/30: 210 is the hardness value, HV is the Vickers hardness value, 50 is the test force F = 50 * 9.82 N = 490.3 N, 30 is the duration of indentation in seconds.



Vickers hardness test





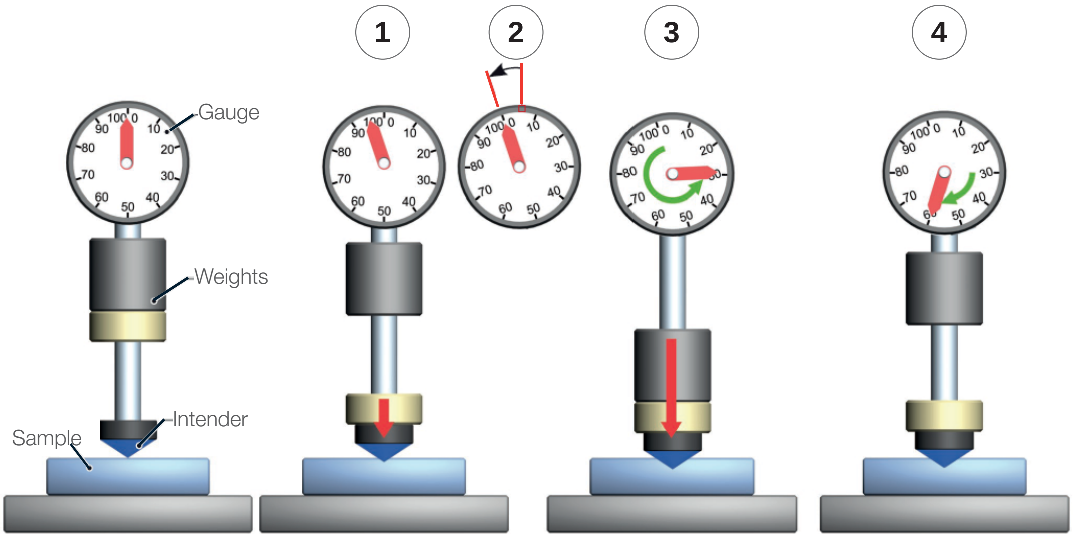
Rockwell Hardness Test

A Rockwell hardness test comprises four work steps:

An indenter is initially pressed into the sample with a test force (e.g.98 N) **(1)** and then the gauge is set to 0 **(2)**. The actual test force (e.g.1,373 N with the HRC method) is then applied **(3)** and removed again after a short time. The remaining penetration depth of the indenter in the sample is read directly on the gauge as the Rockwell hardness **(4)**. For hard materials, a diamond cone is used as the indenter, for soft materials, a hard metal cone is used. To enable testing of materials with different hardnesses, different test forces are used:

HRA: F = 490,3 N, diamond cone	HR15N: F = 117,7 N, diamond cone
HRB: F = 882,6 N, ball	HR30N: F = 264,8 N, diamond cone
HRC: F = 1.373 N, diamond cone	HR45N: F = 411,9 N, diamond cone

The short code for the Rockwell hardness comprises the hardness value and the sign for the method used, e.g. 62 HRC.



Conversion of hardness values from metals

When dealing with the different hardness test methods, it is often necessary to convert the measured hardness value of one method into that of a different method or the tensile strength. For this reason, empirical values have been determined based on a large number of comparison measurements, and conversion tables have been created and standardized in the corresponding standard EN ISO 18265 (previously DIN 50150).

Use the tables with caution. It is not without reason that the following warning precedes each table:

WARNING: Hardness conversion is not a replacement for a direct hardness test. Therefore, these tables should be applied according to the principles explained in Section 3 of the standard.

If conversion is required, the best and most reliable solution is:

- Create your own conversion curve based on your measured values.
- Always specify the conversion uncertainty.
- If relevant, ask the customer to specify which standard table should be used for the conversion, if you do not have your own table.