Shore (Durometer) Hardness Testing of Plastics

The hardness testing of plastics is most commonly measured by the Shore (Durometer) test or Rockwell hardness test. Both methods measure the resistance of plastics toward indentation and provide an empirical hardness value that doesn't correlate well to other properties or fundamental characteristics. Shore Hardness, using either the Shore A or Shore D scale, is the preferred method for rubbers/elastomers and is also commonly used for 'softer' plastics such as polyolefins, fluoropolymers, and vinyls. The Shore A scale is used for 'softer' rubbers while the Shore D scale is used for 'harder' ones. Other Shore hardness scales, such as Shore O and Shore H hardness, are rarely encountered by most plastics engineers.

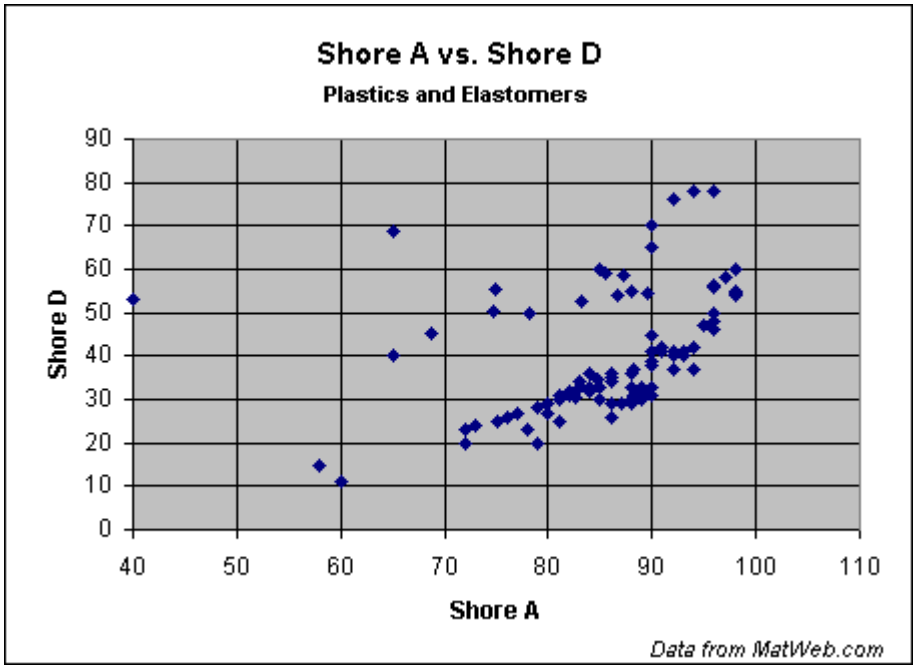
The Shore hardness is measured with an apparatus known as a Durometer and consequently is also known as 'Durometer hardness'. The hardness value is determined by the penetration of the Durometer indenter foot into the sample. Because of the resilience of rubbers and plastics, the indentation reading my change over time - so the indentation time is sometimes reported along with the hardness number. The ASTM test method designation is ASTM D2240 00 and is generally used in North America. Related methods include ISO 7619 and ISO 868; DIN 53505; and JIS K 6301, which was discontinued and superceeded by JIS K 6253.

The results obtained from this test are a useful measure of relative resistance to indentation of various grades of polymers. However, the Shore Durometer hardness test does not serve well as a predictor of other properties such as strength or resistance to scratches, abrasion, or wear, and should not be used alone for product design specifications.

As seen in the charts below, the correlation between the two Shore Durometer hardness scales is weak; attempts at conversion between the scales are therefore discouraged. The correlation is higher for materials with similar resiliency properties, but is still too low for reliable conversions. Likewise, conversion between Shore Hardness and Rockwell hardness is discouraged.

The charts below are taken from data in MatWeb's database provided by polymer manufacturers for specific product grades.

Comparison of Shore Hardness Scales

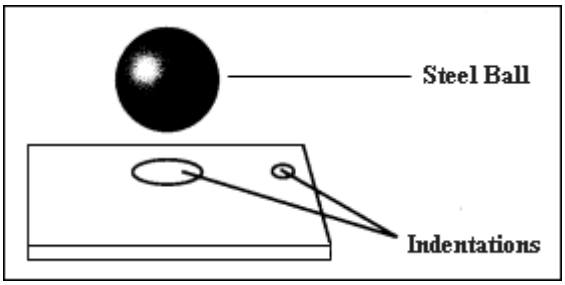


Rockwell Hardness Testing of Plastics

The hardness testing of plastics is most often measured by the Rockwell hardness test or Shore (durometer) hardness test. Both methods measure the resistance of the plastic toward indentation, thereby providing an empirical hardness value. These hardness values do not necessarily correlate to other properties or fundamental characteristics. Rockwell hardness is generally chosen for 'harder' plastics such as nylon, polycarbonate, polystyrene, and acetal where the resiliency or creep of the polymer is less likely to affect the results. The Ball Indentation Hardness test (ISO 2039-1; DIN 53456) is used in Europe much more often than in North America. The Barcol harness test is sometimes chosen for thermoset polymers. The figure below, from Quadrant

Engineering Plastic Products, shows the Rockwell hardness test geometry.

ASTM D785:
A specimen of at least 1/4 inches (6.4 mm) thickness is indented by a steel ball. A small load is applied, the apparatus is zeroed, and then a larger load is applied and removed. After a short time with the preload still applied, the remaining indentation is read from the scale.

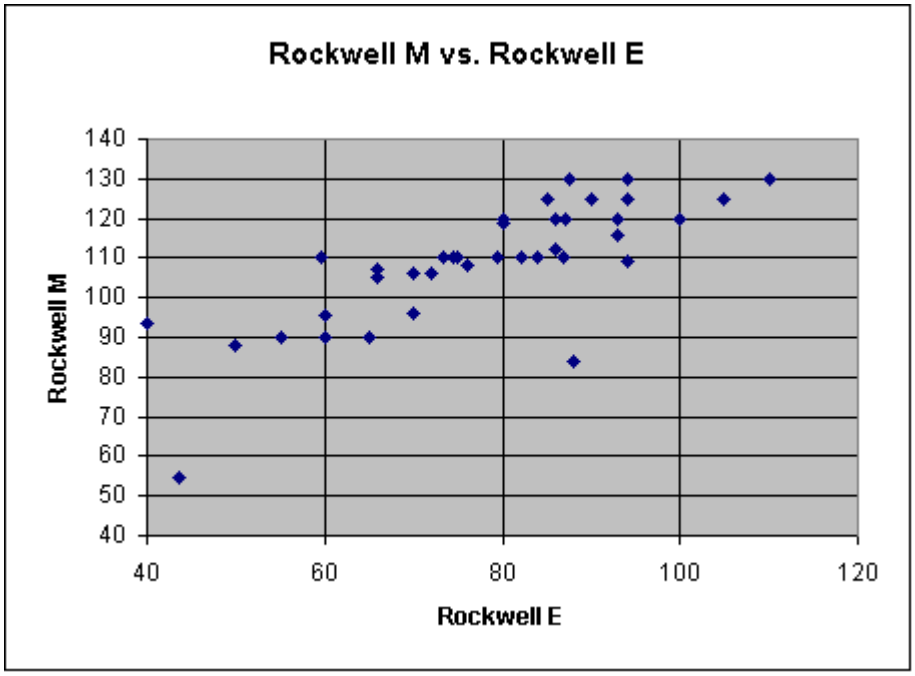


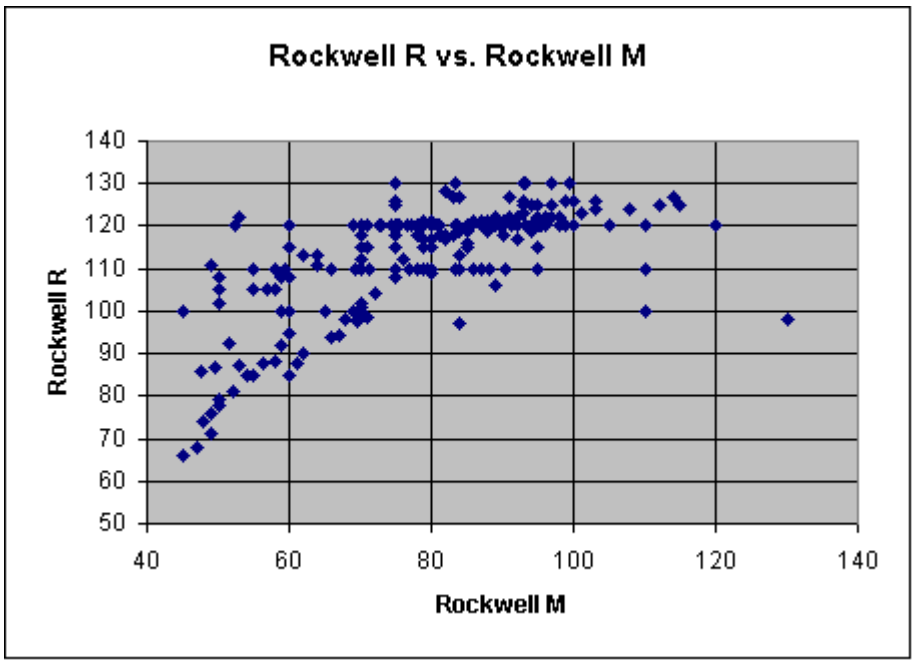
The results obtained from this test are useful measures of relative resistance to indentation of various grades of plastics. However, the Rockwell hardness test does not serve well as a predictor of other properties such as strength or resistance to scratches, abrasion, or wear, and should not be used alone for product design specifications.

Different Rockwell hardness scales utilize different size steel balls and different loads. The three most common scales used for plastics are Rockwell E, Rockwell M, and Rockwell R; results reported from the Rockwell L scale are much rarer. As seen in the charts below, the correlation between the Rockwell scales is weak; attempts at conversion between the scales are therefore discouraged.

The charts below are taken from data in MatWeb's database provided by polymer manufacturers for specific product grades.

Comparison of Rockwell Hardness Scales




Rockwell R vs. Rockwell M
Rockwell R
140
130
120
110
100
90
80
70
60
50
40
60
80
100
120
140
Rockwell M