Vicker's Microhardness

by

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INTRODUCTION

Hardness, an important property in solid state physics, is commonly carried out to determine the mechanical strength of material and it correlates with other mechanical properties like *elastic constants* and *yield stress*.

Hardness is a *measure of the resistance against lattice destruction* or the *resistance offered to permanent deformation* or damage.

The hardness properties are *basically related to the crystal structure of the material*. Microhardness study on the crystals brings out an *understanding of the plasticity of crystals*

HARDNESS MEASUREMENT

Hardness measurement can be carried out by *various methods*. They are classified as

Scratch hardness measurement

Rebound hardness measurement

Indentation hardness measurement

In the first method, which is generally used by mineralogists only, the materials are rated on their *ability to scratch one another*.

In rebound hardness measurement, a standard body is usually dropped onto the material surface and the hardness is measured in terms of the *height of its rebound*.

HARDNESS MEASUREMENT

Indentation tests a load is applied by pressing the indenter at right angles to the surface being tested.

The hardness of the material depends on the *resistance which it exerts during a small amount of yielding or plastic straining*.

The resistance depends on *friction, elasticity, viscosity and the intensity of distribution of plastic straining* produced by a given tool during indentation.

Various indentation hardness tests

- Brinell's Hardness test
- Mayer's Test
- Rockwell's test
- Knoop test
- Vicker's test

HARDNESS MEASUREMENT

The most popular and simplest form is the *static indentation test* wherein the *specific geometry is pressed* into the surface of a test specimen under a known load.

The indenter may be *ball* or diamond *cone* or *diamond pyramid*. Upon removal of the indenter, *a permanent impression* is retained in the specimen.

A pyramid indenter has advantage that geometrically similar impressions are obtained at different loads. So naturally a pyramid indenter is preferred.

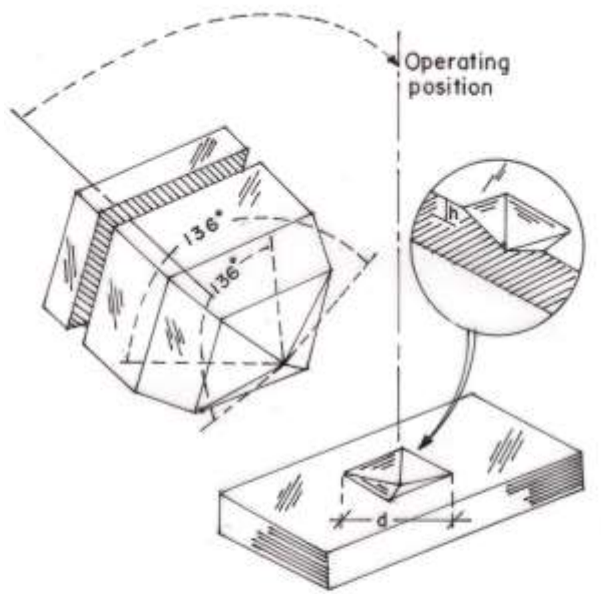
In this static indentation test the indenter is pressed perpendicularly in the surface of the sample by means of an applied load. Then by *measuring the cross sectional area or the depth of the indentation* and knowing the applied load an empirical *hardness number* may be calculated.

VICKERS MICROHARDNESS TEST

Among the various methods of hardness measurements, the most common and reliable method is the ***Vickers hardness test method***.

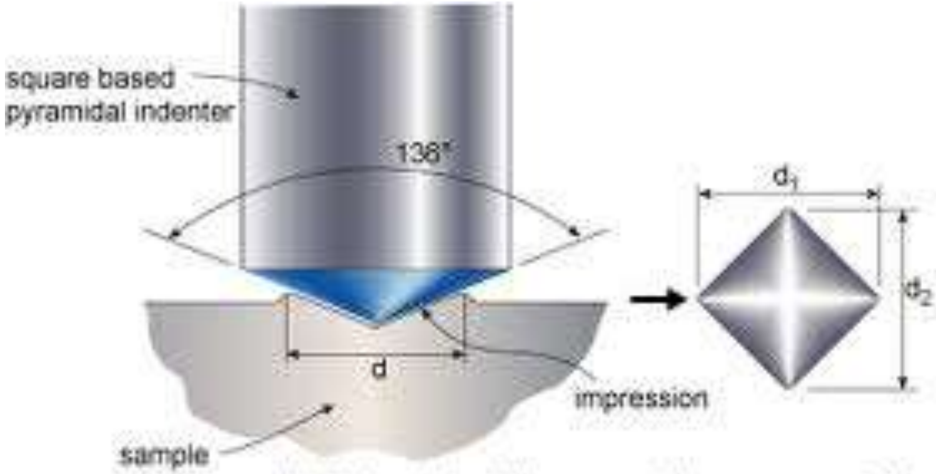
In this method, *microindentation* is made on the surface of a specimen with the *help of diamond indenter*.

In the Vickers test a pyramid indenter with a square base, as shown in Fig.



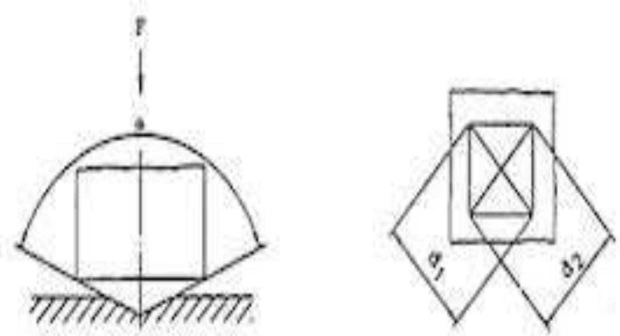
Schematic diagram of Vickers diamond pyramid indenter and indentation produced.

VICKERS MICROHARDNESS TEST

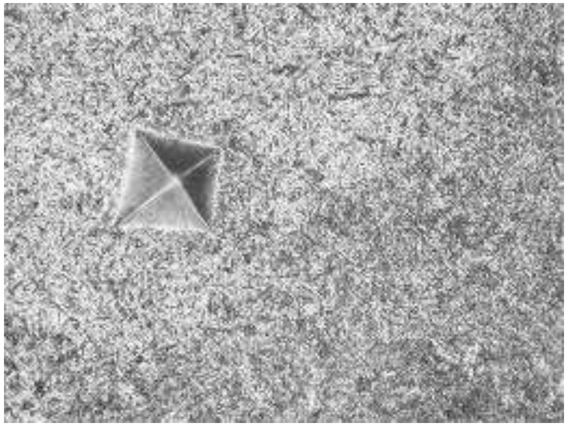


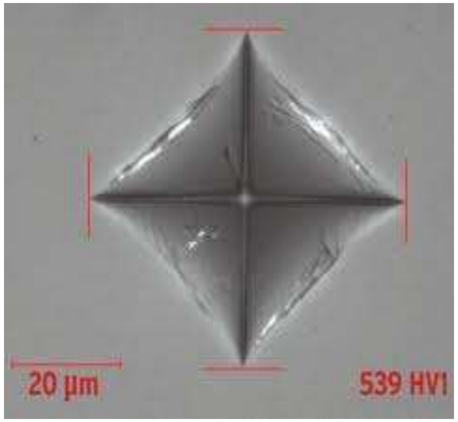
(a) Vickers indentation

(b) measurement of impression diagonals

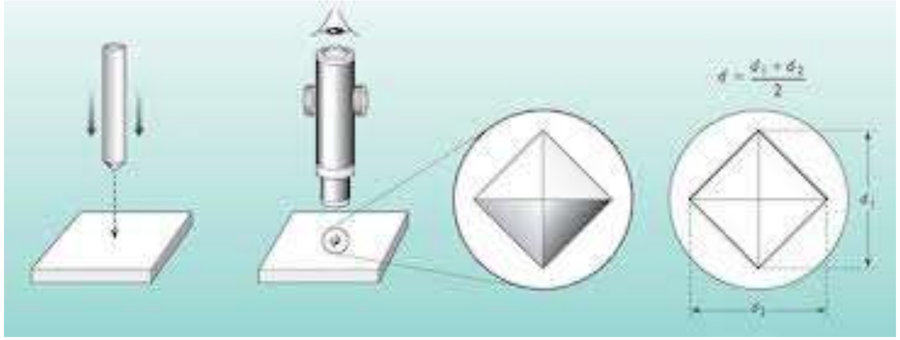


Vickers principle





Vicker’s Hardness tester



VICKERS MICROHARDNESS TEST

The Vickers pyramid indenter where opposite faces contain an angle (α = 136°) is most widely accepted pyramid indenter. A pyramid is suited for hardness tests due to the following two reasons:

The contact pressure for a pyramid indenter is independent of indent size.

Pyramid indenters are less affected by elastic release than other indenters.

The base of the Vickers pyramid is a square and the depth of indentation corresponds *to 1/7th of the indentation diagonal*.

VICKERS MICROHARDNESS TEST

Hardness is generally defined *as the ratio of the load applied to the surface area of the indentation*. The Vickers hardness number H_v of Diamond Pyramid Number (DPN) is defined as

$$H_V = \frac{2P\sin\alpha/2}{d^2} kg/mm^2$$

where α is the apex angle of the indenter (α = 136°).
The Vickers hardness number is therefore calculated from the relation

$$H_V = \frac{1.8544P}{d^2} kg/mm^2$$

where P is the applied load in kg and d is the diagonal length of the indentation mark in mm.

Hardness values are measured from the *observed size of the impression remaining after a loaded indenter* has penetrated and has been removed from the surface.

Thus the observed hardness behavior in the final measurement of the residual impression is the summation of a number of effects involved in the *materials response to the indentation pressure during loading*.

Vicker's Hardness studies

Micro-hardness studies have been carried out on the ***4-hydroxyacetophenone*** single crystals using a *Leitz micro-hardness tester* fitted with a Vickers diamond pyramidal indenter.

Vickers microhardness values have been calculated using

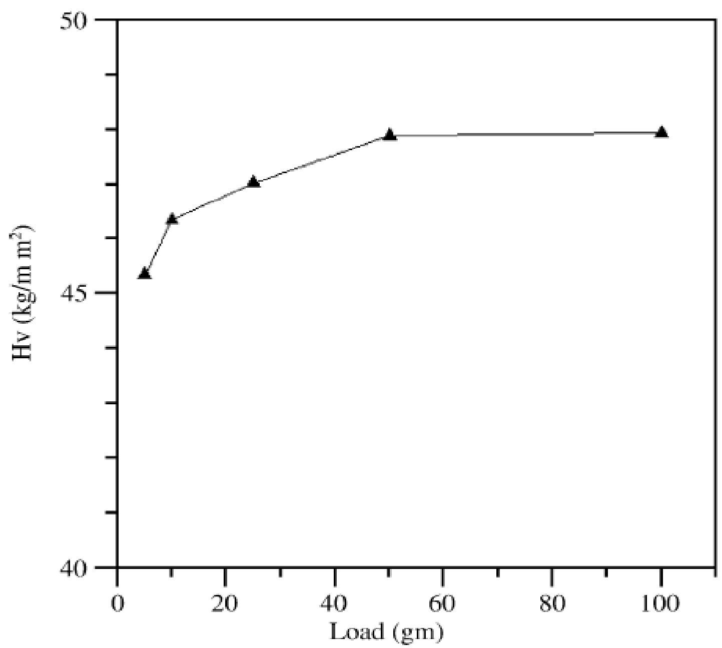
$$H_V = \frac{1.8544P}{d^2} kg/mm^2$$

where P is the applied load and d is the mean diagonal length of the indentor impression. Hardness values have been taken for various applied loads.

A graph has been plotted between hardness number (Hv) and applied load (P) (Fig.)

Vicker's Hardness studies

A plot obtained between ln(P) against ln(d) gives a straight line, which is derived from the Meyer's law, the relation connecting the applied load is given by $P = ad^n$

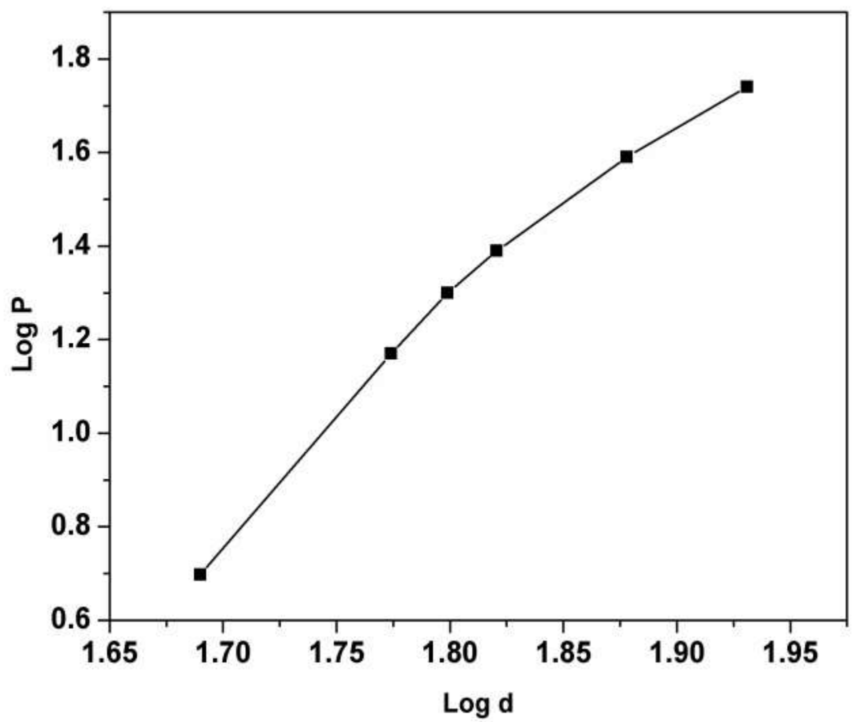


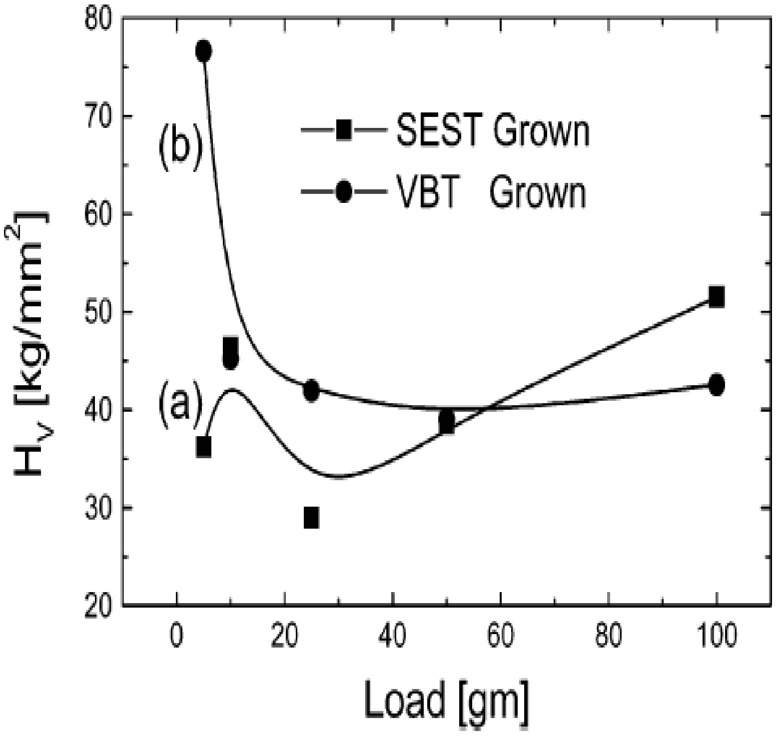
Here, n is the Meyer index or work hardening coefficient and a is the constant for a given material.

The work hardening coefficient n is 2.04.

According to Onitsch, n is greater than 2 when hardness decreases with the increase of load. It satisfies the prediction of Onitsch.

Vicker's Hardness studies





Vicker's Hardness studies

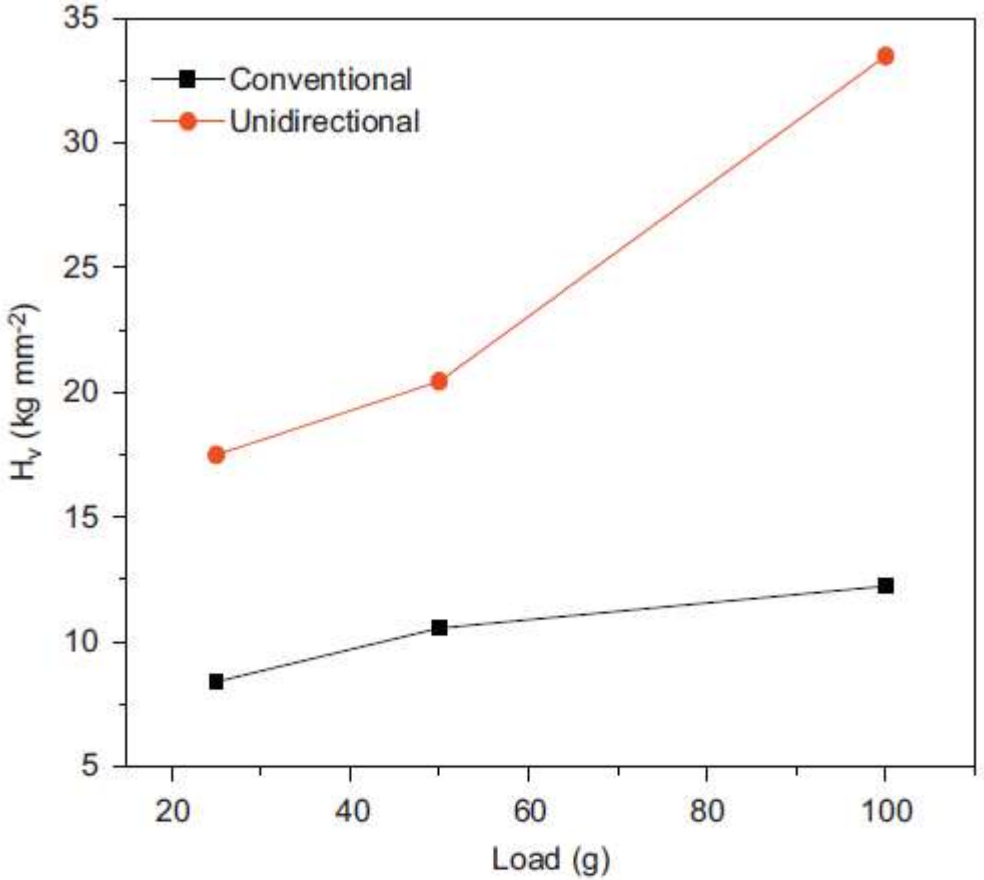


Fig. 4. Plot of microhardness (H_v) vs. load (g) for L-LLDN crystal.

Vicker's Hardness studies