SHIMADZU

Application News

Material Testing System No.i213

Hardness Test on Vickers Hardness Standard Blocks by DUH-211S Dynamic Ultra Micro Hardness Tester

■ Introduction

Hardness is used for evaluating a variety of industrial materials due to its ease of measurement. In particular, "Vickers hardness" is known for its correlation with tensile strength in the measurement of metal materials, and is used widely and practically since it enables specimens to be measured with ease without the need to make specimens in special shapes.
However, in measurement, the size of the indentation must be measured by a microscope. So, when measuring specimens with a thin coating of about 50 µm or less, the measurement result might be influenced by the hardness of the base materials underneath if an indentation having a sufficient size is made in the specimen to ensure measurement accuracy.
The Shimadzu DUH-211 Dynamic Ultra Micro Hardness Tester can test thin-film samples such as these and has a function for converting to Vickers hardness according to ISO. The following introduces the result of a hardness test performed on Vickers hardness standard blocks to check Vickers hardness conversion accuracy on this system.

■ Testing machine and specimens

The testing machine used in this test is the Shimadzu DUH-211 Dynamic Ultra Micro Hardness Tester (shown in Fig. 1), and three micro Vickers hardness standard blocks having different nominal hardness values listed in Table 1 (HMV = 100, 200, 400) were used as the test subjects.

Fig. 1 Overview of Shimadzu DUH-211S Dynamic Ultra Micro Hardness Tester

Table 1 Specimens for Hardness Testing

1) Specimen name	Micro Vickers hardness standard block		
2) Specimen No.	HMV100	HMV200	HMV400

■ Test conditions

The load-unload test was performed on each specimen (three hardness standard blocks) at four test force levels (1 mN, 10 mN, 100 mN, 1000 mN) shown in Table 2. The indenter used was a diamond Berkovich indenter with a tip angle of 115°.

Table 2 Test Conditions

1) Testing machine	Shimadzu DUH-211S Dynamic Ultra Micro Hardness Tester			
2) Indenter	Berkovich indenter with tip angle of 115° (made of diamond)			
3) Test type	Load-unload test			
4) Test force (mN)	1000	100	10	1
5) Loading rate (mN/sec)	70.067	6.6620	0.7316	0.075

■ Test results

Fig. 3 shows the load-unload curve of the hardness measurement results at test force of 1000 mN and 1 mN. It can be seen that satisfactory test results are obtained at the load/unload processes even at an extremely small test force of 1 mN.

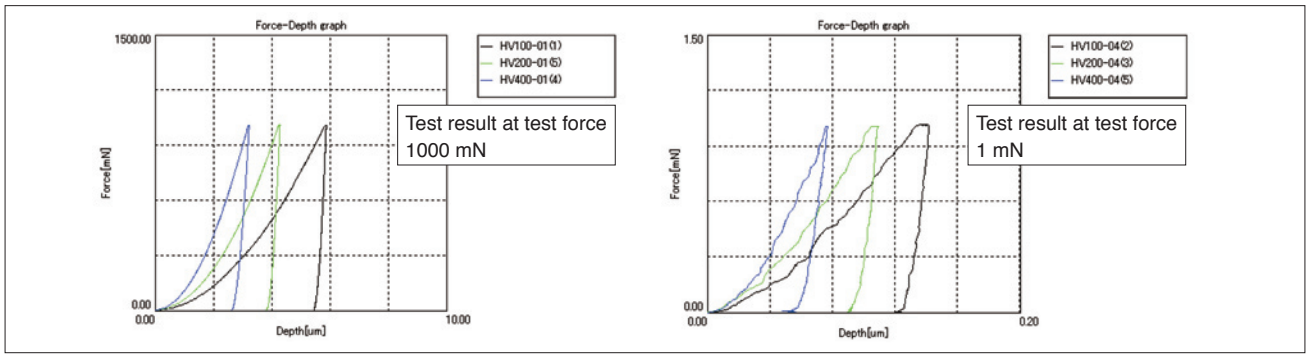

Fig. 3 Test Results (Load-Unload Curve)

Fig. 4 shows the results of calculating the Vickers hardness from this series of measurement data, and Table 3 shows, by way of reference, the hardness values (Vickers hardness) during inspection available from the manufacturer of the hardness standard blocks used as the specimens in this test.

Test Force (mN)	1000	100	10	1
HV400	385.439	428.5	462.189	462.583
HV200	200.618	210.905	231.115	238.505
HV100	102.879	116.005	146.47	153.094

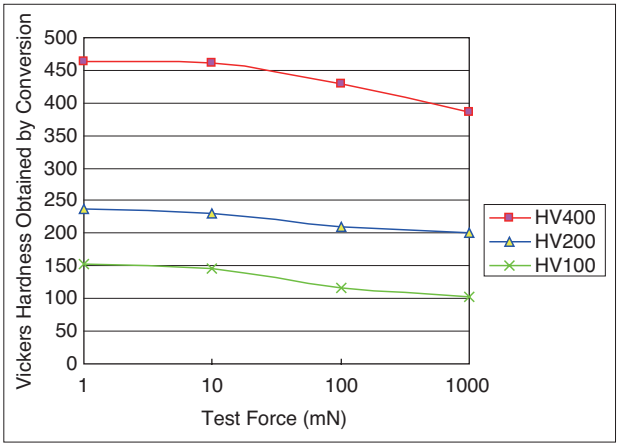

Fig. 4 Test Results

Table 3 Hardness Reference Values of the Standard Blocks

Test Force (mN)	9801	980	98
HV400	397.7	405.8	405.0
HV200	206.8	206.7	206.0
HV100	104.0	108.0	105.5

A comparison of these numerical values shows that in the test force range (98 mN or more) that is used in inspecting the Vickers hardness standard blocks, the error in conversion (to Vickers hardness) by the Dynamic Ultra Micro Hardness Tester is about 10 %. At test forces smaller than this, it can be seen that, even though the error increases, it is still about 50 % even at an extremely small test force of 1 mN.
At a test force of 1 mN, the indentation amount is extremely shallow at about 0.1 to 0.2 μm, which allows the hardness of thin films of about 2 μm to be measured. The results of this test show that conversion to Vickers hardness is possible at a fixed accuracy even with thin films such as this.
It is considered very significant that the Shimadzu DUH-211S Dynamic Ultra Micro Hardness Tester offers a means of assessing even the Vickers hardness of thin films that cannot be measured by a Vickers hardness tester.

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