

Application News

Material Testing System

No.i203

Hardness Test on Hair by DUH-211S Ultra Micro Hardness Tester

Introduction

People's hair is subjected to various external damage daily. Various factors cause hair to be impaired or damaged. Of these, it is said that friction, heat and hair treatment such as poor haircuts and perms account for most of these factors.

In this test, we tried evaluating hair by "hardness" that

had deteriorated, in particular, as a result of being treated with chemicals, and hair, on the other hand, that was not treated by any artificial means. The "Shimadzu DUH-211S Ultra Micro Hardness Tester" (Fig. 1), which is compatible with the measurement of micro objects, was used for measuring hardness.



Fig. 1 Overview of DUH-211S

Test specimen and test conditions

Table 1 shows the three specimens used. (Hair specimens B and C were treated with different chemicals.)

Table 1 Specimens

1) Specimen name	Hair		
	Untreated hair	Treated hair	
2) Specimen No.	A	B	C
3) Specimen size	Hair thickness : approx.100 μm		

Remarks) The three samples were taken from the same person under the same conditions.

The test was performed using the equipment and conditions in Table 2. Fig. 2 shows a conceptual diagram.

Table 2 Test Conditions

1) Indenter	Berkovich indenter (made of diamond)
2) Test type	Load-unload test
3) Test force (mN)	9.80
4) Loading rate (mN/sec)	0.488
5) Holding time (sec)	2
6) Test method	Both ends of the hair (approx. 10 cm section from hair root) were fixed in place on the glass plate by adhesive tape, were further stuck to the glass plate with a thin coating of instant adhesive, and a load was applied. (See Fig. 2.)

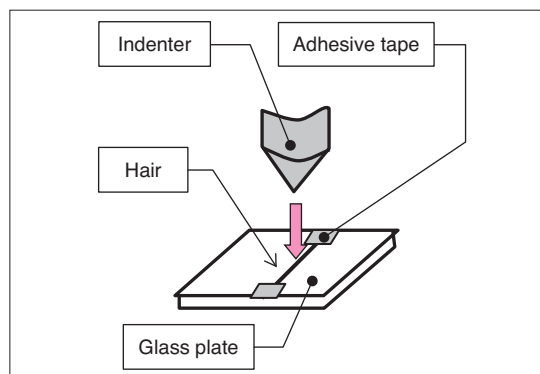


Fig. 2 Conceptual diagram

■ Test results

Table 3 shows the results of the hardness test on the three hairs. Hardness was evaluated by Martens hardness (HMT115) and Vickers hardness obtained by

conversion (HV*).

Also, Fig. 3 shows the "force-depth" relation for each specimen.

Table 3 Test Results

Specimen Name	Specimen No.	Fmax [mN]	hmax [μm]	HMT115 [N/mm ²]	HV*
Hair	A	9.88	1.374	176.8	22.9
	B	9.85	1.505	146.8	19.2
	C	9.87	1.185	237.3	33.9

Note) The meanings of the symbols in the table above are as follows:

Fmax: max. force hmax: max. depth value

HMT115: Martens hardness by Berkovich indenter (115° triangular pyramid indenter) $HMT115 = Fmax / (26.43 \times hmax^2)$

HV*: Vickers hardness obtained by conversion (reference value)

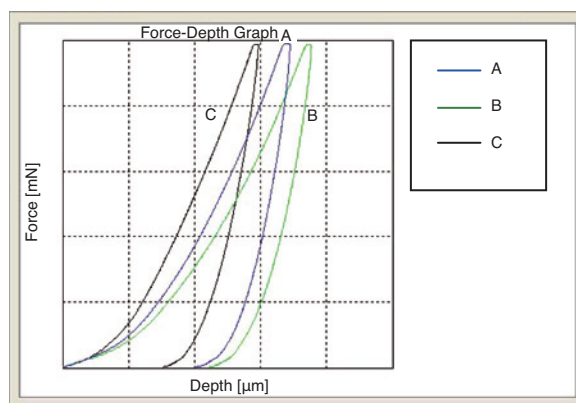
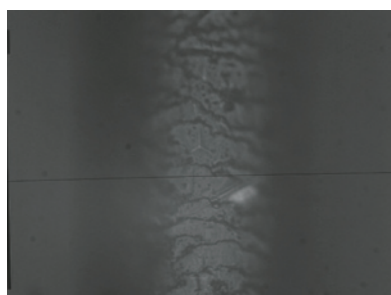


Fig. 3 Force-Depth Relation

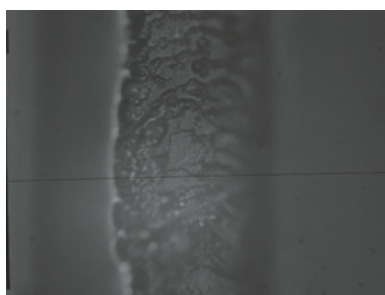
The above results show that the order of hardness, beginning with the hardest specimen, is specimen C > specimen A > specimen B, in terms of both Martens hardness (HMT115) and Vickers hardness obtained by conversion (HV*).

By way of reference, if you also look at the photographs

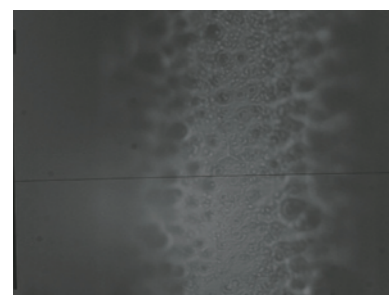
(Fig. 4) of the surface of each specimen observed by a microscope, it can be deduced that specimen B has swollen as a result of treatment and is softer than specimen A, and that specimen C has lost its cuticle and is harder than specimen A.



Specimen A



Specimen B



Specimen C

Fig. 4 Observation of Hair Surface