

**USER'S MANUAL**

# **BARCOL HARDNESS TESTER**



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## 1. Introduction

Barcol Impressor is an indentation hardness tester originally made in the USA. It has 3 models in series. 934-1 is the typical model which is in widest application.

Barcol Impressor is mainly applied in two areas: One is aluminum fabrication industry, to test pure aluminum, soft aluminum alloys, thick aluminum alloys, aluminum belts, aluminum alloys extrusions, bars, castings, forgings and assembled aluminum alloy parts (e.g. Al-alloy door & window, curtain wall etc.) Relevant standard is American standard ASTM B648-00 《Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor》; the other is fiber reinforced plastics industry, most of the domestic and abroad fiber reinforced plastics products are required to test Barcol hardness. Relevant standard is American standard ASTM D2583-07 《Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor》.

Barcol Impressor is light weight and portable. It can be used by single hand operation; no operating experience required; can test any workpiece which is reachable on any site. Barcol Impressor has following features: Wide valid testing range equivalent to Brinell hardness 25-135HBW. Used to test the hardness of all kinds of aluminum, from very soft pure aluminum to very hard aluminum alloys; Extended application. Model 934-1 is applied to test the hardness of aluminum, aluminum alloys, copper, copper alloys, fiber reinforced plastics and rigid plastics etc. The modified models of it are available to test very soft metals such as lead, tin and other soft materials such as soft plastics, rubber, felt and leather etc; High sensitivity. Featured with 100 scales, it is much more sensitive than Webster hardness testers applied in aluminum alloys industry; No supporting is required. It can test from only one side of the workpiece. No need to move or support the workpiece. It is used to test very large or thick workpieces and assembly parts. The test results can be directly converted to HB, HR, HV and HW through conversion table.

Barcol Impressor is a kind of indentation hardness tester. It uses a special shape indenter impressed into the specimen by a standard spring pressure and measures the indentation depth to obtain hardness value.

Barcol hardness value is:

$$HBa = 100 - \frac{h}{0.0076}$$

HBa — Barcol hardness value

h — Indentation depth (mm)

“0.0076” — Indentation depth for one unit of Barcol hardness

## 2. Principle and Structure

The structure of Barcol Impressor is illustrated in Fig.1.

The main testing system of Barcol Impressor is set in the frame. The indenter is in the full scale adjusting screw (indenter sleeve) with a plunger loaded by load spring on top. The test force applied on indenter by load spring through plunger is adjusted by

load adjusting screw. The plunger moves up and down along with indenter; thus, the dial indicator shows hardness reading through the lever. The legs fixed at the back of the frame can ensure the indenter be perpendicular to test surface. The enclosures at both left and right sides protect the inner system from being damaged and changed.

The top of indenter is 0.76mm upper on the top surface of full scale adjusting screw, equivalent to 100 degrees when the impressor is under nonworking condition. The indicator points at zero at this moment.

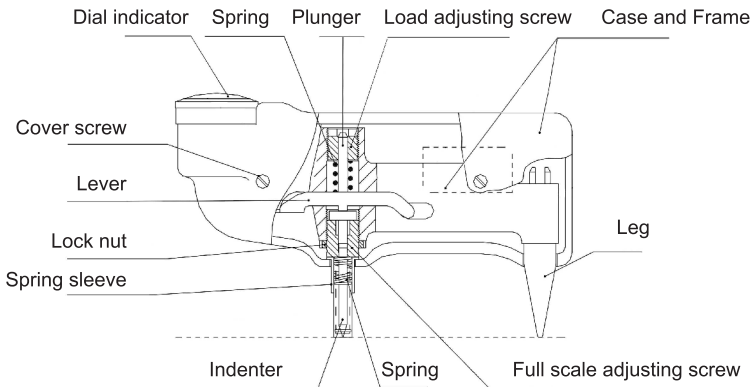


Fig.1 Structure of Barcol Impressor

### 3. Technical Parameters

Indenter:	26° truncated cone, head face diameter 0.157mm
Testing Range :	0~100HBa, equivalent to 25~135HBW
Resolution:	0.5HBa
Indication error:	hardness range 81~88HBa $\pm 1$ HBa hardness range 42~48HBa, $\pm 2$ HBa
Repeatability:	hardness range 81~88HBa $\pm 1.5$ HBa hardness range 42~48HBa, $\pm 2.5$ HBa
Net weight:	0.5kg

### 4. Operating Method

#### 4.1 Verification of the Instrument

##### 4.1.1 Zero Point Verification

Check the position of the indicator hand. It should point at the "0" on the indicator dial. The tolerance range should be within one graduation. If it exceeds, please contact with the manufacturer.

##### 4.1.2 Full Scale Verification

Put the impressor on a hard flat surface (e.g. glass sheet). Press on the enclosures to make the indenter totally back to full scale adjusting screw. Now the indicator should

point at  $100 \pm 1$  (Note: Do not impact or make the indenter slide broadwise when pressing, otherwise the indenter will be damaged). If the test reading exceeds the tolerance range (1 graduation), calibration of the full scale should be carried out according to Step 5.3.

#### 4.1.3 Indication Verification

Put the two standard hardness blocks on a hard flat surface and test them with the instrument. The test reading should be within the tolerance range of the hardness of hardness blocks. If not, calibration of the indication should be carried out according to Step 5.3.

### 4.2 Requirement of Specimen

4.2.1 The specimen surface should be smooth, clean, without mechanical damage. The surface can be lightly polished to remove the scratch and coating.

4.2.2 The thickness of the specimen should be no less than 1.5mm. Obvious transformation should not be observed on the back of the specimen after testing. The dimension of the specimen should also ensure the minimum distance between the indentation and each edge to be greater than 3mm.

4.2.3 To ensure accurate testing, the indenter must be vertical to the specimen surface. Thus, the dimension of the specimen surface should be big enough to make the leg of the impressor and the point of the indenter at the same level.

If the specimen is too small or narrow to make the leg of the impressor and the point of the indenter at the same level, block up the leg to realize it. Pay attention that the two surfaces of the leg should be at the same level.

4.2.4 Make sure there is no previous testing indentation within 3mm around current testing point.

4.2.5 The specimen must be placed stably. Small specimen should be placed on the stable backing (such as steel sheet, glass etc.) The specimen should not lift, move or transform during testing procedure.

### 4.3 Testing Operation

Hold the instrument and put it on the specimen stably. Apply the test force firmly and swiftly. Take the maximum reading on the dial estimated to 0.5 hardness unit. This reading result is the Barcol hardness value of the specimen. Do not impact or make the indenter slide sideways when pressing, otherwise the indenter will be damaged.

When testing softer materials, the reading will be lower down gradually. Take the reading as promptly as possible to take the maximum reading result.

## 5. Calibration of the Instrument

### 5.1 Calibration of zero point

The zero point of the instrument is stable and seldom changes. If it goes wrong, calibration of zero point should be carried out under manufacture's guide.

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## 5.2 Calibration of full scale

Screw off the enclosure screw, and take out the main frame from the enclosure. Then screw off the lock nut and rotate the full scale adjusting screw with the special wrench equipped with the instrument. The reading on the dial indicator will be lower down when the nut is screwed loose, on the contrary, rise up when screwed fastened. After adjustment, screw the lock nut and test again on the glass sheet. The indicator should point at  $100\pm 1$ . If there is still any error, repeat the operation above until the indicator points at  $100\pm 1$ .

## 5.3 Calibration of the indication

Screw off the load adjusting spring. The reading on the dial indicator will be lower down when the spring is screwed loose, on the contrary, rise up when screwed fastened. Repeat the operation above until the indicator points at the hardness value of the standard hardness block.

Test on the other standard hardness block. The indicator should point at the hardness value of the standard hardness block. If there is still any error, do light adjustment. Test the instrument on both "hard" and "soft" standard hardness blocks after adjustment. The indicator should both point at the hardness value of the standard hardness block. If not, the indenter is worn or damaged. Replace with a new one.

# 6. Indenter

## 6.1 Protection of the Indenter

The indenter of the instrument is an accurate part made of hard steel. The point of the indenter is machined accurately to a very small size. Take care during operation to avoid any damage. When the indenter reaches the specimen, the instrument should be pressed carefully and firmly to avoid slide or scratch. The indenter will be damaged if it slides on hard material especially on rough hard material. The indenter is not covered in the warranty, so it must be treated with care. Please replace it for a new one if it is damaged. Each instrument is attached with 2 spare indenters. Contact the local distributor when more indenters are needed.

### **Caution!!!**

**Do not grind and reuse the damaged indenter!**

## 6.2 Wearing of the indenter

The indenter will be lightly worn after frequent use. In that case, the error of the test result will increase. So the indenter should be checked regularly.

Put the instrument on a glass sheet. The indicator should point at full scale  $100\pm 1$ . If not, it means the indenter is worn. It also indicates the indenter is damaged if the readings do not match the hardness value of the standard hardness block when testing the instrument on the same surface.

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The calibration of the instrument should be carried out if the indenter is worn. Test the instrument on both “hard” and “soft” standard hardness blocks after adjustment. The readings should all point at the hardness value of the standard hardness block. If not, the indenter may be seriously damaged; its length can not meet the required range; replace with a new one. Another calibration procedure should be carried out after replacing the indenter.

### **6.3 Replace the indenter**

The procedure of replacing indenter is as following:

6.3.1 Screw off the screw on the enclosure.

6.3.2 Hold on the spring sleeve to make sure it does not fall off. Take off the main frame of the instrument from the enclosure.

6.3.3 Screw off the load adjusting screw until the cross groove projects from the main frame.

6.3.4 Invert the instrument. Prevent the spring and plunger from falling down. Screw off the lock nut and take off the full scale adjusting screw.

6.3.5 Take off the previous indenter and put on a new one. Screw the full scale adjusting screw. Make the indenter reveal 5mm from the bottom of the frame.

6.3.6 Test on the glass sheet and take the maximum reading. Do not overload and avoid indenter over-deflecting. If the indicator reading exceeds 110, the dial indicator will be damaged. Adjust the full scale adjusting screw until the indicator points at  $100 \pm 1$ .

6.3.7 Screw the lock nut. Recheck full scale value.

6.3.8 Inspect and calibrate the instrument.

6.3.9 Assemble the instrument back and check the full scale and the test blocks.

## **7. Hardness Block**

The instrument is attached with two hardness blocks, “high value” and “low value” which are made of aluminum and aluminum alloys.

Only the front side of the hardness block with the hardness value is permitted to be used. Testing on both the two sides will lead to wrong readings.

Avoid testing on the point within 3mm distance from the edge and previous indentation when testing the hardness block.

The reading obtained near the previous indentation will be not accurate.

Each instrument is attached with enough quantity of hardness blocks. Spare hardness blocks can be bought from the local distributor.

## **8. Test Times**

The error of Barcol Impressor is bigger than Brinell hardness tester and Rockwell hardness tester. In order to reduce the test error, test for several times and take the average reading. The softer specimen is, the more test times need to be carried out.

The number of tests should be even more when testing on composite materials.

The recommended number of tests according to different hardness value on homogeneous material and heterogeneous material are shown in table 1 and table 2.

Table 1 Recommend number of tests for aluminum alloys materials (According to ASTM B648-2000)

Barcol Hardness	Min. Number of Tests
50	6
60	5
70	4
80	3

Table 2 Recommend number of tests for fiber reinforced plastics and rigid plastics

Rigid plastics		Fiber reinforced plastics	
Barcol Hardness	Min. Number of Tests	Barcol Hardness	Min. Number of Tests
20	9	30	29
30	8	40	22
40	7	50	16
50	6	60	10
60	5	70	5
70	4		
80	3		

## 9. Model Selection

There are 3 models in Barcol series.

Model 934-1 equipped with standard load spring and standard indenter is in the widest application. It is used to test aluminum and aluminum alloys, copper and copper alloys, fiber reinforced plastics, other reinforced plastics and non-reinforced plastics etc. Its testing range is equivalent to 25-135HBW (500kg, 10mm). The typical Barcol hardness of aluminum and aluminum alloys of different designations and conditions are shown as table 3:

Table 3 Typical Barcol hardness of aluminum alloys

Alloys and Heat Treatment	1100-0	3003-0	3003H14	2024-0	5052-0	5052H14	6061T6	2024T3
Barcol Hardness	35	42	56	60	62	75	80	85

Model 935 which is equipped with softer load spring and standard indenter, used to test softer plastics, soft metals such as lead, tin and wooden products like floor etc. Its testing range is equivalent to 50-110HRR.

Model 936 equipped with softer load spring and indenter with bigger cone angle is used to test even softer materials such as leather, asphalt felt and soft wood etc.

### 10.Collocation

#### Standard Package

- Tester
- Leg
- Standard hardness block (2 pcs)
- Spare indenters (2 pcs)
- Calibration wrench
- Carrying case

#### Optional Accessories

- High value Standard hardness block
- Low value Standard hardness block
- Spare indenter

### 11.Conversion

Barcol hardness can be converted to HB, HR, HV and HW, as shown in Table 4, Fig 2 and Fig 3.

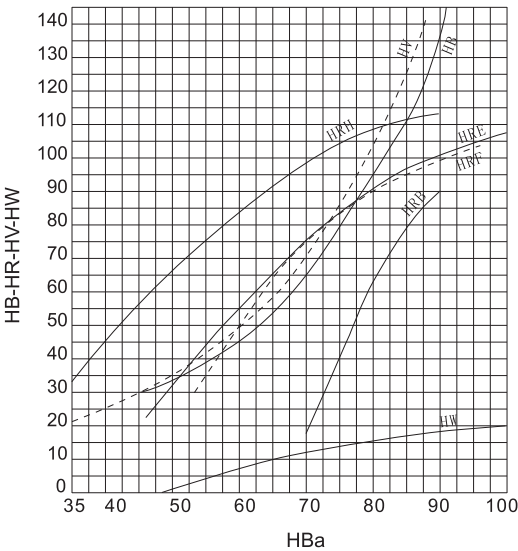


Fig 2. Relation between HBa and HB, HR, HV and HW

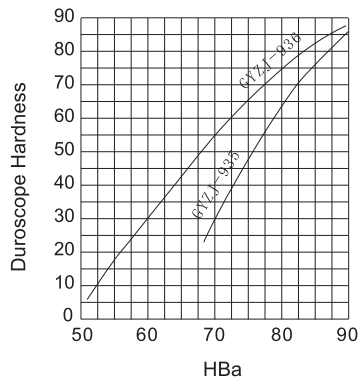


Fig 3. Relation between HBa and Duroscope hardness



Table 4. Hardness Conversion Table

HBa	HB 10mm 500kg	HV 5kg	HW	HR				HBa	HB 10mm 500kg	HV 5kg	HW	HR			
				B	E	F	H					B	E	F	H
35		21					32	68	60	65	11.0		71	70	94
36		22					35	69	62	67	11.4		73	72	95
37		23					37	70	64	70	11.8	17	75	74	97
38		24					40	71	67	72	12.2	23	76	75	98
39		25					42	72	69	75	12.6	28	78	77	99
40	25	26					45	73	72	78	12.9	33	80	79	100
41	25	27					47	74	75	81	13.3	38	81	80	101
42	26	28					49	75	78	85	13.7	42	83	82	102
43	27	29					51	76	80	88	14.0	47	84	83	103
44	27	30					54	77	84	92	14.3	51	86	85	104
45	28	30					56	78	87	95	14.7	55	87	86	105
46	29	31					58	79	90	99	15.0	59	89	88	106
47	30	32					60	80	94	103	15.3	63	90	89	106
48	30	33	0.7			23	62	81	97	108	15.6	66	91	90	107
49	31	34	1.3			26	64	82	101	112	15.9	70	92	91	108
50	32	35	1.9			28	66	83	105	117	16.2	73	94	92	109
51	33	36	2.5			31	68	84	109	121	16.4	76	95	93	109
52	34	38	3.1			34	70	85	113	126	16.7	79	96	94	110
53	35	39	3.6			36	72	86	117	131	16.9	81	97	95	111
54	37	40	4.2			39	73	87	121	137	17.2	84	98	96	111
55	38	41	4.7			41	75	88	126	142	17.4	86	99	97	112
56	39	43	5.3			44	77	89	130		17.6	88	100	98	112
57	40	44	5.8			46	78	90	135		17.8	90	101	98	113
58	42	45	6.3			48	80	91	140		18.0		102	99	114
59	43	47	6.8			50	82	92	145		18.2		103	100	
60	45	49	7.3			53	83	93			18.4		103	100	
61	46	50	7.8			55	85	94			18.6		104	101	
62	48	52	8.3			57	86	95			18.7		105	102	
63	50	54	8.8			59	88	96			18.9		106	102	
64	51	56	9.2			61	89	97			19.0		106	103	
65	53	58	9.7			63	90	98			19.2		107		
66	55	60	10.1			65	92	99			19.3		107		
67	57	62	10.6			67	93	100			19.4		108		

Note: Because of the nature of soft metals, different testing can not establish uniform relationship between each other. So the conversion table and curves are only for reference. It is recommended to create a conversion table for Barcol hardness through actual testing on each kind of material.



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