



EFFICIENCY SAVINGS IN CHD HEAT TREATMENT CONTROL PROCESS SAMPLE PREPARATION AND HARDNESS CHECKING

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Introduction

This article is about improving efficiency by using more automation in processing samples for Core Hardness Depth (CHD) measurements. It highlights best practice in shorter semi-automatic sample preparation procedures in comparison to traditional manual or semi-automatic methods. Tests were carried out on a heat-treated part commonly found in Automotive and Aerospace industries, and calculations are made to demonstrate a typical Return on Investment (ROI).

Sample Preparation, faster preparation with PlanarMet 300 & EcoMet AutoMet 300 bundle Grinding Polishing Procedure

The procedure consists of a 3-step procedure involving a PlanarMet 300 planar grinder and EcoMet AutoMet 300 polishing machine. This allows you to prepare up to 10 mounted samples (subject to the part size and desired area of inspection). The example shown is for 6 samples mounted in 40mm mold size. The preparation procedure is tabulated below



Figure 1 polishing process steps: clamping, grinding and polishing

Table 1 parameters for PlanarMet 300 and Ecomet / Automet 300 polishing

	Surface	Abrasive	Central Force (for 6 specimens)	Time (min: sec)	Platen Speed (rpm)	Head Speed (rpm)	Rotation
<i>PlanarMet 300</i>							
1	Alumina Wheel	120grit	180N	00:30	Fixed	100	>>
<i>EcoMet AutoMet 300</i>							
1	Hercules S/ UltraPad	9µm Metadi Supreme	180N	04:00	200	60	>>
2	MicroFloc/ VerduTex	3µm Metadi Supreme	180N	03:00	200	60	>>

NOTE: Polishing cloth selection depends on the type of analysis desired:

- For a 9µm cloth selection, Hercules S is preferred for a fast and powerful action on standard heat treated parts and to use UltraPad cloth for heat treated part with brittle white later as found on Nitrided components or for unmounted sample polishing applications.
- For a 3µm cloth selection, VerduTex is preferred for excellent flatness and fast damage removal but residual scratches from 3µm might be evident and aid to get the right focus during hardness measurements procedure. For scratch-free surfaces, MicroFloc cloth is the preferred surface for microstructural analysis.



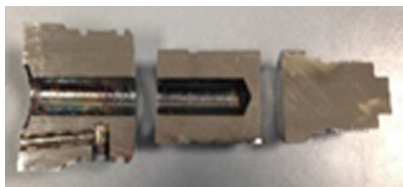


Table 2 Polishing Methods Comparison

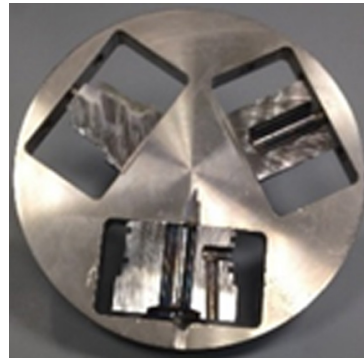
	Traditional Manual Way To get 6 samples done one by one	Semi-Automatic Way To get 6 samples done at the mean time	Updated Way To get 6 samples done at the mean time
Loading Samples On Central Force Holder		2:00	2:00
Remove Cutting Artefacts	P120 3:00	P120 1:00	Alumina Wheel 120grit 5:00
Get Flat Samples	P320 3:00	P320 1:00	
Cleaning Samples		0:30	0:30
Get Samples Back In Integrity	P600/P1200 6:00	Diamond 9µm 5:00	Diamond 9µm 4:00
Cleaning Samples	02:00	0:30	0:30
Get Polished Surface	Diamond 3µm 10:00	Diamond 3µm 3:00	Diamond 3µm 3:00
Cleaning Samples	2:00	0:30	0:30
Preparation Time	26:00	10:00	08:00
Operator Time	26:00	03:30	03:30

Operator interaction is required during all the steps

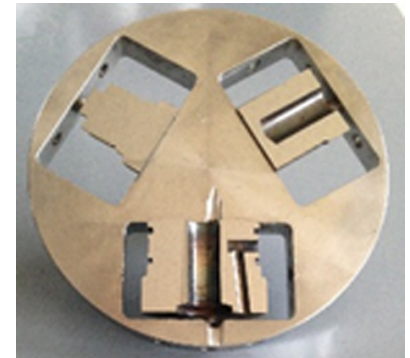
The following comparison table highlights how investing in semi automation for samples preparation saves you money and time by increasing laboratory productivity with better quality samples, procedures that is repeatable and safe to do.



After Cutting



After PlanarMet 300



Ready for Inspection

The PlanarMet 300 offers the opportunity to meet high sample throughput due to its capability for high stock removal rate and presenting a surface ideal for coarse polishing. The adoption of a planar grinder cuts down the number of steps required for sample preparation saving operator time for other laboratory tasks. As shown below, the method can also be adopted for the preparation of unmounted parts and offers excellent surface finish and flatness.

Table 3 Quality Consistency

	Traditional Manual Way	Semi-Automatic Way	Up to Date Way
Typical surface quality from each method			
Comments	Over polished edges with edge rounding affecting focus issues during CHD or decarburization inspection	Remaining deep scratches on the edges of larger unmounted samples can affect accuracy of CHD measurements	Perfect flatness with a scratch free surface ideal for both CHD and microstructural analysis
Grinding steps thickness removal rate for 6 samples	0,05 mm/min	0,15 mm/min	0,3 - 0.5 mm/min - depend on desired stock removal level
Edge retention, flatness, quality	Poor	Average	Very Good
Operator dependent	100%	40%	20%
Safety	Poor	Very Good	Very Good



Hardness control, resource time savings with DiaMet automation

Lab Case

The following example illustrates an extremely demanding CHD measurement control for a heat-treated part. Three specimens are sectioned out at 120° from a shaft, mounted and semi-automatically prepared as illustrated in Section 1. For CHD control measurements, 8 locations are selected on each sample consisting of 12 points each, so around 96 indents per sample totalling around 300 indents for each batch.

Automation Process

Polished samples are fixed in our new magnetic multiple sample holder. In the example shown below, Figure 2, 6 samples are easily placed without any specific orientation: This is a tool less operation. Make it easy! Slide the holder on the table and plug it on the 2 magnetic stops. You're already in focus!

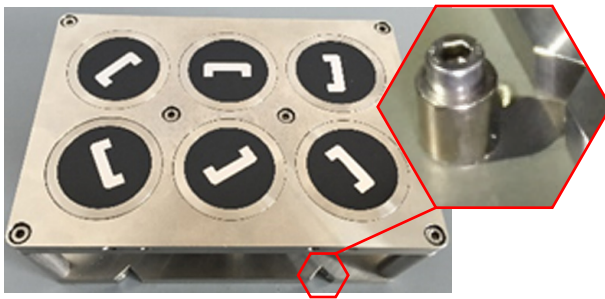


Figure 2 shows a 6-sample holder clamping fixture for multiple sample testing

Second step is to make a quick contour of your sample and select the appropriate stored template. DiaMet automatically adjusts the template position to match the contour scan and you are ready to go! The 8 locations and 12 points at each location for this example are instantly preset as shown below. Each location has got a row of 8 points that should be setup on dedicated locations with specific coordinates on the sample.

With any standard system, completing this task requires a huge amount of time to the operator, with an additional risk of potential error.

The enhanced DiaMet template function is the key for all kinds of heat treatment control processes in Automotive and Aerospace industries. You can save a significant amount of time using Buehler DiaMet hardness automation software, incorporating the Auto-Snap and Template functionality to instantly position the locations for each row of tests, and respective multiple indent points in each location.



Simply Click start! Thanks to the Auto Snap, a unique function, all locations will automatically be adjusted to the edge at high magnification as figure 3, for best accuracy. DiaMet automatically

completes all indents, autofocuses and measures. DiaMet also saves all the measured indents at high magnification that can be revisited to further validate the accuracy of measurements and do fine adjustments if necessary.

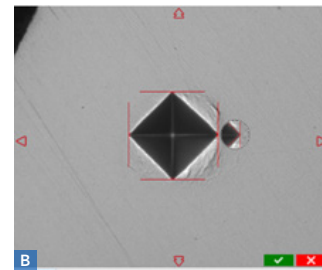
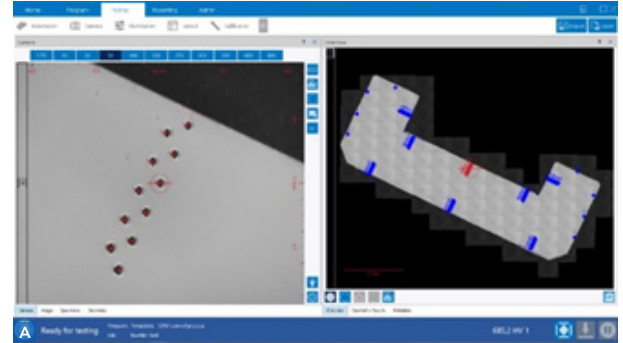
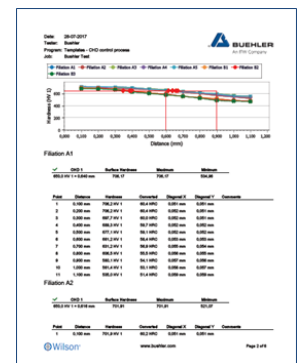
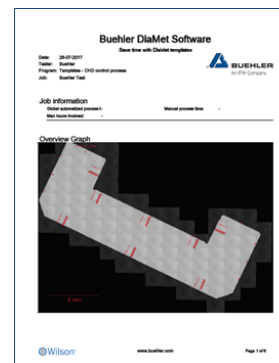


Figure 3 (a) illustrates auto-snap and validation of location placement on the samples at higher magnification and (b) shows a saved high magnification indent including a magnifying window for fine adjustments if desired

Get your Graphics and reports in one click



The graphical display charts within the software plot the 8 locations for an immediate check of conformance, highlighting the crossover points where the hardness level from the surface drops below the preset minimum case hardness level, figure 4. The charts also display the case depth distance at this cross over points for all the locations that can be validated if they meet the tolerances set for the parts being tested.

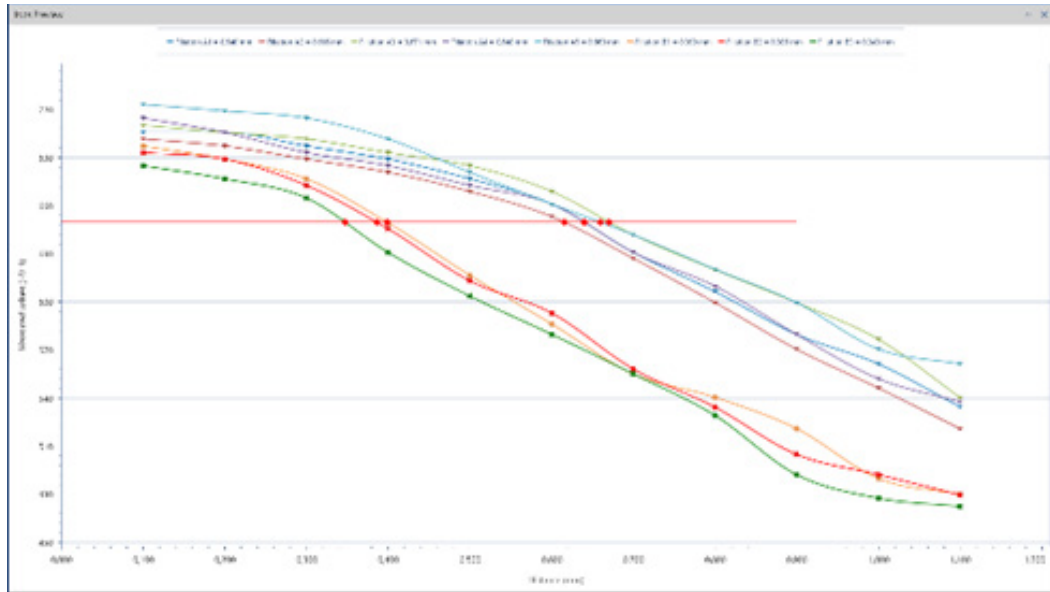


Figure 4 shows a chart within Diamet visually displaying the CHD plots from 8 locations highlighting the crossover points (red line) where hardness drops below the preset minimum

Your Savings vs Manual & Semi-Automatic Process			
For 3 Samples	Manual Operations	Semi-Automatic	Automatic DiaMet New Functions
Global process time	1.5 day	5h	2h30
Man power	1.5 day	2h30	30min

Return on Investment			
	Manual Operations	Semi-Automatic	Automatic DiaMet New Functions
ROI (ratio)	1	1/15	1/72

Conclusions

- Semi-automatic sample preparation using a planar grinder for quick initial stock removal and presenting a surface ideal for the integrity stage before a fine polishing step. This allows development of faster 3-step procedures that offer significant process and operator time savings.

- The use of Diamet controlled automation in hardness testing significantly reduces the time required for performing hardness checks from a day and a half to just a couple of hours. Therefore, the return on investment (ROI) from using automation to achieve case hardening depth (CHD) analysis is quite relevant. This is especially relevant for high throughput quality control laboratories. Diamet's simplicity and accuracy also helps users in responding to standard quality requirements and getting graphics and reports in one click.



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