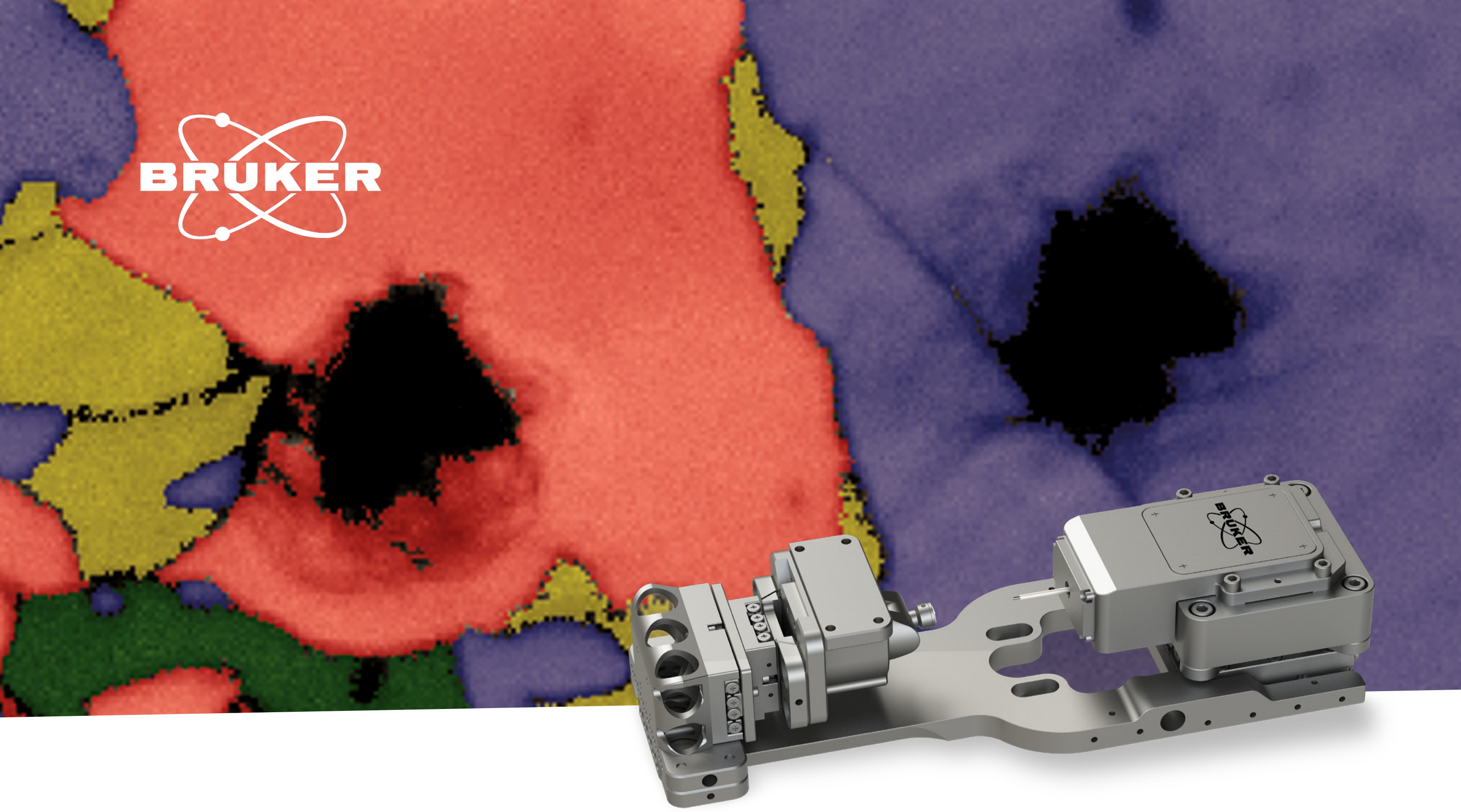

SEM PicoIndenter Series

Hysitron PI 89 Auto SEM PicoIndenter

Automated In-Situ Nanoindentation for High-Throughput Co-Localized Imaging and Metrology

PI 89 Auto is an automated version of the PI 89 system designed for high-throughput testing. It incorporates seamless imaging/EBSD/EDS (Electron Backscatter Diffraction/Energy Dispersive Spectroscopy) interfacing using the encoded linear stages and a patented dual-configuration rotation and tilt (R/T) mechanism.

PI 89 Auto Includes:

- Base PI 89 platform with controller
- Advanced rotation and tilt (R/T) stage
- TriboScan Auto software, which enables automation testing capabilities

The main objective of PI 89 Auto is to establish a correlation between the structure, processing, and properties of various materials. This correlation can aid in understanding the relationship between the microstructure of materials and their mechanical and functional properties. Overall, PI 89 Auto represents an innovative advancement in materials testing and analysis, with the potential to enhance industrial processes and improve the performance of materials used in various sectors.

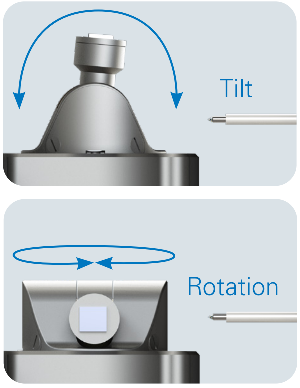

FIGURE 1

The SEM and EDS signals can be captured by using the tilt function of the R/T stage, and EBSD mapping can be obtained using the rotation and tilt functions.

Only PI 89 Auto Delivers:

- High-throughput automated nanoindentation with limited user interaction
- Co-localized metrology with SEM imaging and EBSD/EDS analysis for structure-processing-property correlations supporting materials development
- A patented dual-configuration rotation and tilt stage to easily align with relevant detectors

Case Study: Laser Clad Region

PI 89 Auto was used to investigate the laser clad region of 410 stainless steel on a 4140 steel substrate. During the laser cladding process, a heat-affected zone (HAZ) is formed at the base of the laser cladding area.

SEM Imaging: Three distinct layers were observed: the 4140 substrate, the HAZ of the 4140 substrate, and the 410 stainless steel.

EDS Elemental Analysis: There were chromium-rich layers in the 410 stainless steel region and iron-rich phases in both the 4140 substrate and HAZ.

Nanoindentation for Mechanical Properties: Seven positions across the layers were selected on the live SEM image using the TriboScan Auto software. At these positions, partial unloading indentations were performed, and hardness and modulus profiles were generated.

Correlated Results and Analysis: Results indicate that the heat-affected zone exhibited higher hardness than the 410 stainless steel and the 4140 substrate. The 4140 steel microstructure is altered by the high heat, causing an increase in hardness from to a thin layer with small grains and martensite at the grain boundaries.

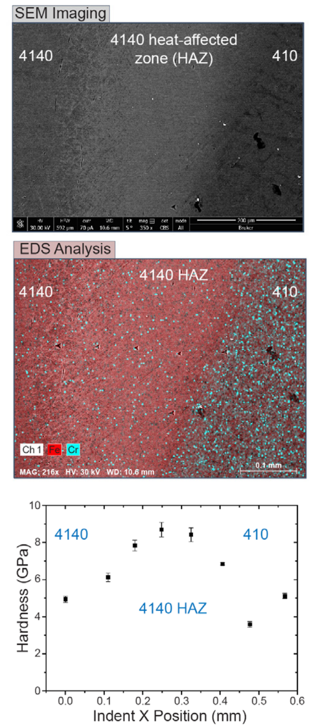

FIGURE 2

Co-localized SEM imaging (top), EDS analysis (middle), and hardness profiling (bottom) of a laser clad region of 410 stainless steel onto a 4140 steel substrate.

PI 89 Auto Specifications

Load with base PI 89 Auto	10 mN
Load noise floor	<400 nN
Maximum displacement with base PI 89 Auto	5 µm
Displacement noise floor	<1 nm
Option – Maximum load	300 mN
Load noise floor	<5 µm
Option – Maximum displacement	150 µm
Displacement noise floor	<1 nm
Stage travel (x, y, z), where y is the indentation axis	26 mm, 29 mm, and 12 mm
Linear stage resolution	1 nm
R/T stage travel	180° and 90°
R/T stage resolution	0.33° rotation stage, 0.18° tilt stage
Overall positioning accuracy from imaging and EBSD position	Typically 5 µm*

*The accuracy specification may change depending upon the SEM environment, SEM stage encoder, stage heating, and drift. Guaranteed accuracy <30 µm.

Bruker Nano Surfaces and Metrology
Minneapolis, MN • USA
Phone +1.952.835.6366

productinfo@bruker.com

www.bruker.com/PI89-Auto