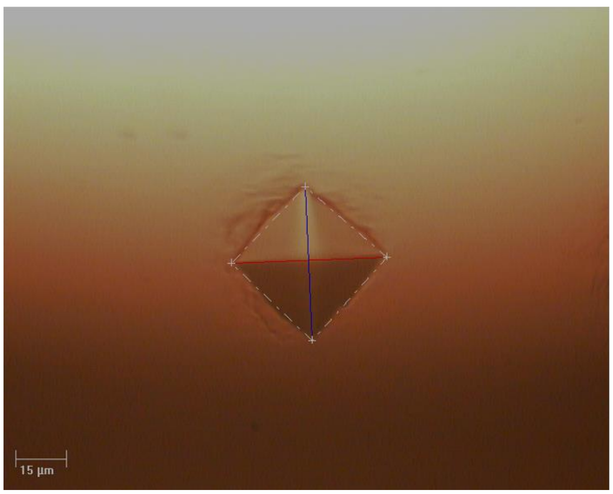
Exponential Business and Technologies Company

Bridge You and Nano

Case Hardening Depth measurement of Self-Drilling Steel Screw

Can you believe that fastener failures are the number one cause of mechanical failures in industry? To improve the mechanical properties of fasteners, case hardening is a popular technique due to its ease of implementation and cost-effectiveness. To evaluate the quality of the case hardening process on fasteners, one of the most basic methods is to measure the thickness of the case-hardened layer.

The routine method for testing case depth is microindentation. In this work, Vickers hardness testing was performed to measure the case depth thickness. After the hardness test, the sample was etched using Nital etchant (3 vol.% HNO_3 in ethanol solution) to reveal more morphological details in the sample surface. The etched sample was then inspected by optical microscopy and SEM. The case hardened screw was cut through the radial direction and mounted in epoxy. The cross section was then polished by sand paper and a polishing cloth using a 0.3 µm Al_2O_3 suspension to form a smooth and scratch free surface. Vickers hardness was measured using a CSM Micro-Combi Indentation and Scratch Tester. Figure 1 shows a typical diamond shape Vickers indent and the Vickers hardness traverse. Based on the hardness traverse, the total thickness of the carburization layer is approximately 300 µm.



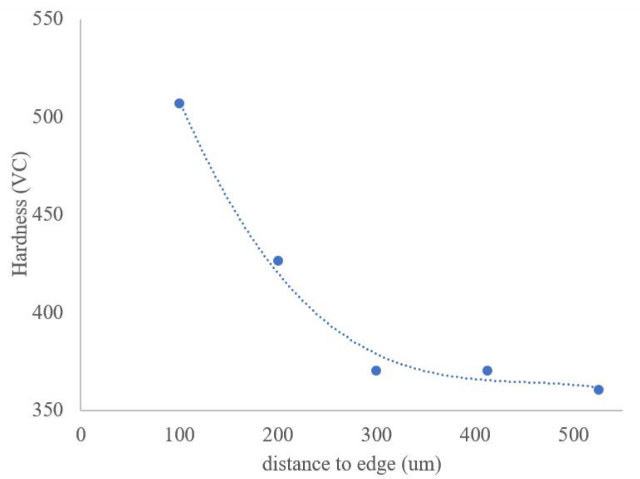


Figure 1. (Left) Typical diamond shape Vickers indent; (right) Vickers hardness traverse for the case hardened screw cross section.

The SEM/EDS line scanning result of the sample's carbon content is shown in Figure 2. As indicated in Figure 2, the carbon concentration decreased from the surface towards the center. After about 300 µm, the carbon concentration become stable, which is consistent with the hardness measurement results from Figure 1.

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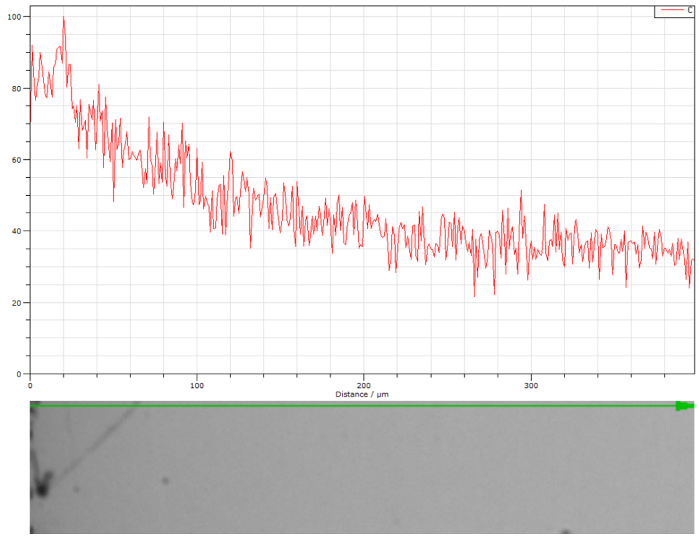

Figure 2. EDS line scanning result of carbon content from the sample surface to the center.

Figure 3 compares the microstructure of the sample area close to the surface and the sample area near the center. The black microstructure is possibly martensite, which is a regular microstructure produced during the quenching process. The white microstructure may have been the residual austenite. During the quenching process, the cooling rate at the surface was higher than the cooling rate in the center of the sample. The difference in cooling rates translates to a higher concentration of martensite on the surface of the sample than in the center.

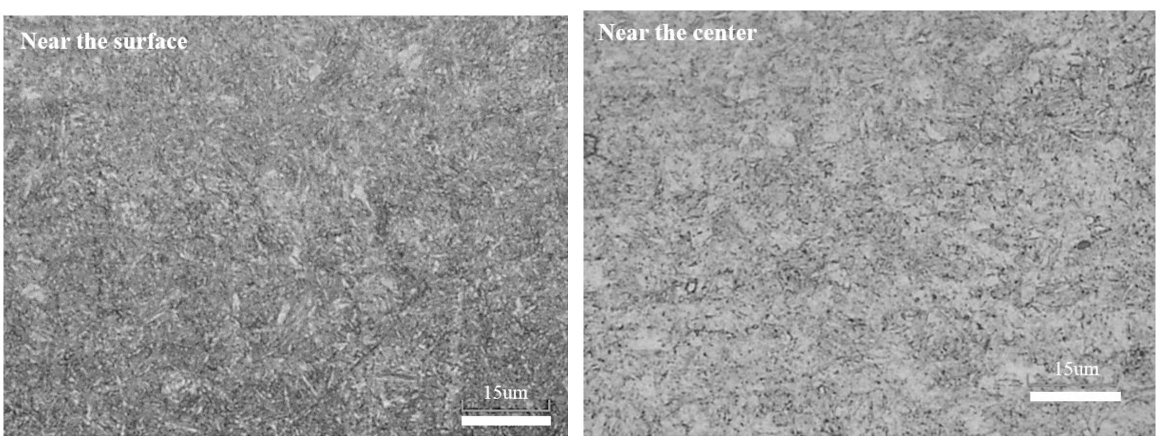

Figure 3. Microstructure of the self-drilling screw surface at area close to the edge (left) and center (right). Sample was etched by 3% Nital etchant.