Integration of Large-Chamber Scanning Electron Microscopy and Image-Stitching Techniques to Characterize Full-Sized Components

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Small chambers of conventional scanning electron microscopes have always been the limiting factor for full-size part evaluation. As a result, large components must be sectioned to view the area of interest. This not only destroys the specimen, it introduces anomalies that could result in misinterpretation of the diagnostics.

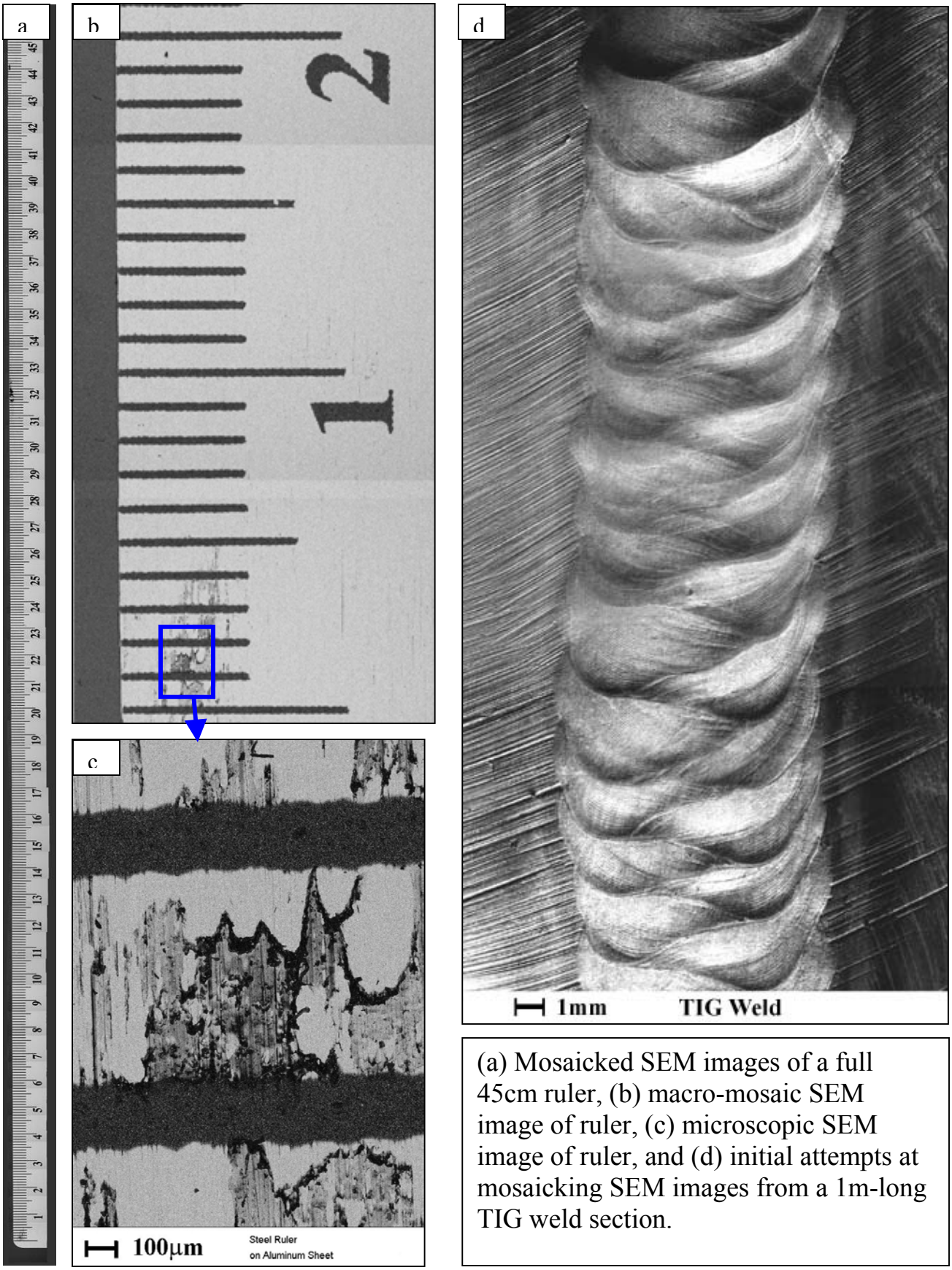
The Y-12 National Security Complex in Oak Ridge, TN is currently using a new large-chamber scanning electron microscope (LC-SEM) that has the largest chamber in the world at eight cubic meters. The instrument can examine specimens measuring up to 1-m in diameter by 1-m tall and weighing as much as 300-kg. This microscope provides high-resolution images at magnifications from 10x to 200,000x, while using a mobile column that moves around the sample on a four-axis positioning system. The LC-SEM is also equipped with the most extensive array of analytical equipment of any SEM in the world for comprehensive imaging and mapping.

The Imaging, Robotics, and Intelligent Systems (IRIS) Lab at the University of Tennessee has developed algorithms for mosaicking of SEM images that are proving ideal for characterizing large components with the LC-SEM. A method called Orientation Correlation is used that is specifically suited for registering images with translation shift. Orientation images are derived from the two or more images to be mosaicked and are matched by maximizing the correlation between them. The location of maximum correlation determines the parameters of the mosaic.

By merging these two technologies, complete diagnostics are possible over a macroscopic range. A stitched mosaic of the significant area provides an overall view of the section of interest, while maintaining the high resolution of the individual images. This panoramic view generates an orientation relative to the entire component and yields critical information on surface morphology and chemistry at one glance.

These techniques will be demonstrated by imaging lateral and circumferential welds up to one-meter in length. Along with general weld morphology, EDS mapping can be superimposed to determine trends in weld chemistry. These examples will establish the baseline for further investigations, quality assurance, and certification.

The integration of mosaicking techniques with the LC-SEM technology provides a new process for surface diagnostics never before achievable in the field of conventional scanning electron microscopy.



(a) Mosaicked SEM images of a full 45cm ruler, (b) macro-mosaic SEM image of ruler, (c) microscopic SEM image of ruler, and (d) initial attempts at mosaicking SEM images from a 1m-long TIG weld section.