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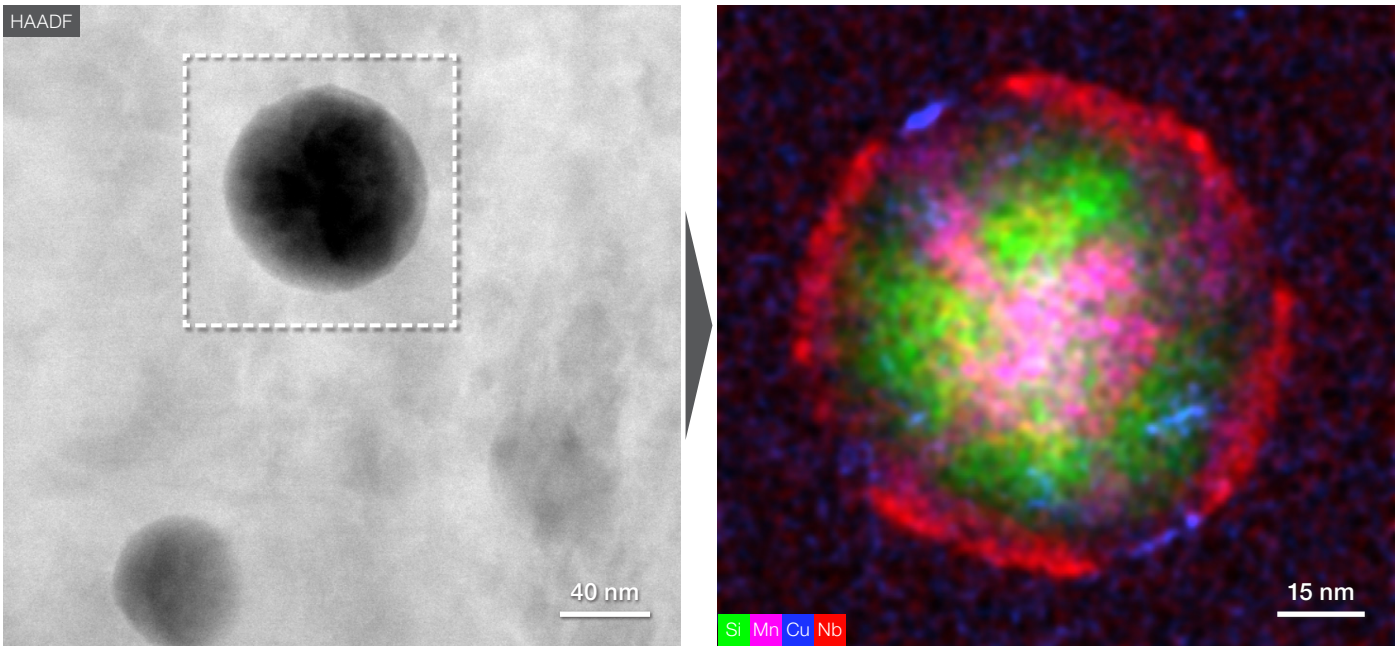
Ultimate solution for nanoparticle characterization with the Automated Particle Workflow

Introduction

Nanoparticles are utilized to improve product or process performance in an increasing number of industries, including catalysts for chemical reactions and high-strength alloys. As these particles may be smaller than 10 nm, a transmission electron microscope is required to resolve the fine particle details. Adding to the challenge, these particles may be made up of multiple compounds, where it is important to distinguish between them.

This application note demonstrates how the Thermo Scientific™ Automated Particle Workflow (APW), available on both the Thermo Scientific™ Talos™ TEM and Spectra™ (S)TEM, can be used as a high-resolution transmission electron microscope workflow for statistically relevant analysis on complex phases in precipitation hardened steel. It will demonstrate that APW can be used for the complex quantification of Si/Nb compound nanoparticles (60% of Si nanoparticles are Si/Nb compound) using an additively manufactured 17-4PH stainless steel component.



Talos F200X (S)TEM analysis of additively manufactured stainless steel showing: a) HAADF STEM image of a precipitate embedded in stainless steel, and b) manual EDS mapping of the complex precipitate.

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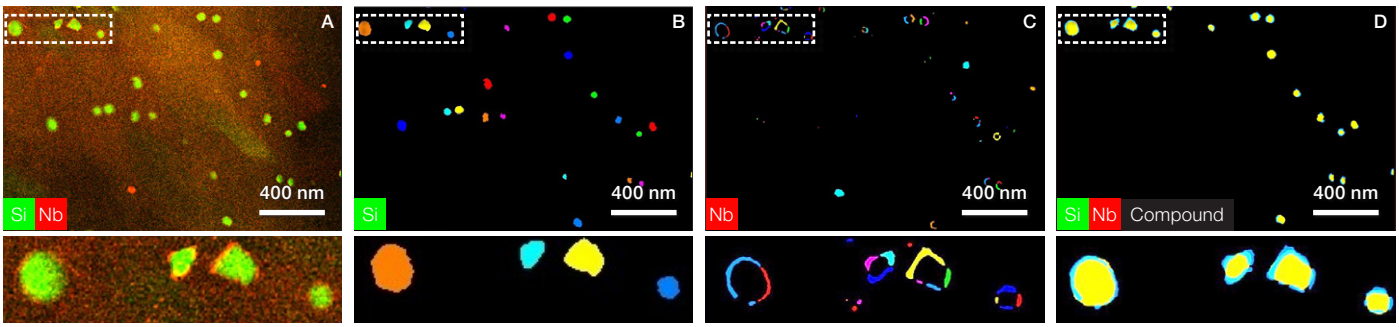


High-resolution APW analysis showing: a) EDS maps of precipitates including silicon (green) and niobium (red), b) segmented silicon precipitates, c) segmented niobium precipitates, and d) compounds precipitates of silicon and niobium.

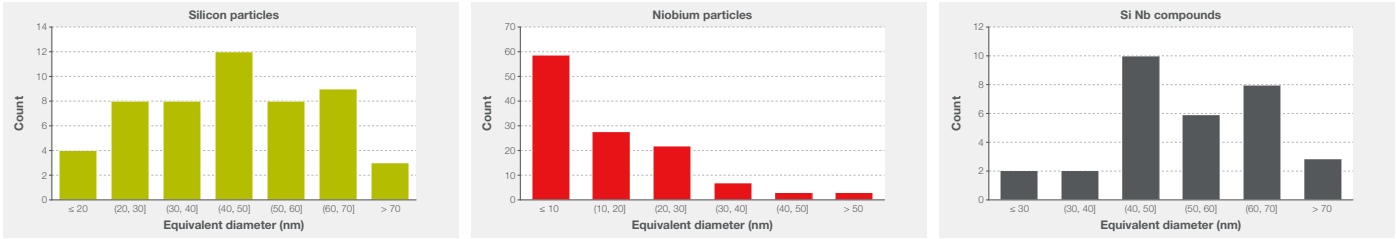
Challenge

Complex, nanoscale phases can be laboriously identified through manual EDS mapping sessions lasting ten or twenty minutes for a single particle (120 particles per 40 hour week). This is simply not an efficient way to chemically characterize hundreds or thousands of particles.

Simple image analysis could be used to quantify particle size and shape, but this would be missing important chemical information. For the evaluation of new processes to produce higher strength alloys or to evaluate the aging behavior of catalyst particles, it is imperative to reconcile particle count, size, and composition with the specific processing conditions.

Solution

APW is an ideal solution for nanoparticle characterization, combining large-area and high-resolution imaging acquisition. It streamlines the workflow from sample to particle analysis by automating navigation, data acquisition, particle segmentation, and statistical analysis of morphological and chemical information. Automation controls navigation, focus, drift correction, tiling, stitching, and storing, all of which can be performed overnight and unattended. Process improvement can be completed on a much shorter schedule. Statistically relevant data sets on complex nanoparticles can be compiled in a single day with high-resolution, automated TEM.



High-resolution APW analysis showing size distributions of: silicon precipitates (count = 51, ave 43.6 nm), niobium precipitates (count = 122, ave 15.2 nm), and compound precipitates of silicon and niobium (count = 31, ave 53 nm).

Automated Particle Workflow in action

Duration 0:53

Find out more at **thermofisher.com/APW**

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