Optical Microstructural Characterization of Highly Deformed and Etch Resistant Materials

CJ Hawkins, Dr. Terry Lowe – Transdisciplinary Nanostructured Materials Research Team

Motivation

Often in research access to advanced characterization techniques are readily available and used without a second thought. However, outside of specialized research institutions such equipment is often unavailable with this in mind my research has been focused on determining a way to translate results from advanced methods to more readily available optical microscopes.

Polish Samples for Metallographic Study
Identify Features in Optical Microscopes
Analyze Features Using Energy Dispersive Spectroscopy

Material

For this research I have focused on Inconel 625, a nickel-based superalloy commonly used in aerospace applications. This material is being studied for use in medical devices due to its strength and remarkable corrosion resistance. Before continuing its development for use in humans research must be done on its composition and structure to predict its biocompatibility.

Optical Results

SEM Results

Three distinct objects were found in optical microscopes. Orange colored particles with marks around them. Gray particles with marks and gray particles without marks.

In a scanning electron microscope (SEM) the same regions were scanned along the green arrows using energy dispersive spectroscopy (EDS) to identify what elements are present.

EDS Line Scans

Results and Conclusion

Based on the color alone it is possible to determine what the particle is comprised of without the need for more advanced methods.

- Orange colored precipitates
  - Are rich in niobium and titanium
- Light gray precipitates
  - Are rich in niobium
- Darker gray precipitates
  - Are rich in niobium, molybdenum, and carbon
- All identified precipitates contain less nickel and chromium.

Each of these precipitates will behave differently within the body by being able to easily identify them in optical microscopes future collaborators will be able to study each precipitate without the need of SEM or EDS.

Continuing this research by treating surfaces with chemical etchants could reveal new particles that can be characterized with the same technique.

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