MATERIAL CHARACTERIZATION FOR HIGH FIELD MAGNET TECHNOLOGIES

Greg Fritjofson¹ Yan Xin² Jun Lu³
¹Trevecca Nazarene University, Nashville, TN 38002
²National High Magnetic Field Laboratory, Tallahassee, FL 32310

STEM IMAGE PROCESSING FOR MATERIALS RESEARCH

High field magnets like those produced in NHMFL utilize an array of specialized materials. It is useful in materials research to have a method of quantitatively analyzing materials on the atomic scale.

Absolute Integrator version 1.6.4 is a MATLAB program designed by STEM specialist Dr. Lewys Jones. It uses Fourier Transforms to calculate and recognize regular pattern in the microstructure of STEM images, and then optimizes peak selection of atomic columns by calculating the diameter of the columns in pixels. Jones’ Ranger Version 2.4 uses Gaussian surfaces to calculate the total integrated intensity of all the given atomic columns.

GOAL: MAKE DATA ACCESSIBLE

BACKGROUND- Dr. Lewys Jones

INTENSITY SELECTOR

- Allows the user to view particular selected atomic column intensities of their analyzed STEM image.
- Provides the user a way to check intensity data of a particular group and assess if is in the expected range in correlation to other columns.

INTENSITY SORTER

- Allows the user to select a regularized sample of the STEM image.
- It then groups the atomic columns of the STEM image by intensity.
- Exports the position and intensity data into a table saved for use with Excel and ODF format programs. This allows the analyst to precisely locate, atomically group, and characterize any atomic column in the image.

FUTURE WORK

- Create a Graphical User Interface (GUI) to make these programs easier to operate, reducing the need for training.

MICROHARDNESS TEST OF MP35N SUPER ALLOY

MP35N is a nickel-cobalt base super alloy used in the reinforcement structure of pulse magnets in Los Alamos National Laboratory. The alloy’s strength is directly correlated to the aging effect of heat treatment. The Vickers Hardness (HV) of MP35N is tested at various heat treatment durations and temperatures to optimize the tensile strength of MP35N and ultimately the structural stability of pulse magnets.

DATA ACQUISITION

- Microhardness evaluation is then prepared at 300g force with the Tukon 2100™ Microindentation Vickers Hardness Tester.
- Images are taken at 1000 times magnification with OLYMPUS BX60M™ optical microscope using the Image-Pro 6.2 interface.
- Images are measured in ImageJ with a calibration factor of 11.977 pixels/micron.

ANALYSIS / RESULTS

VICKERS HARDNESS: Untreated and 500C 144 min

- Across indentations of the same sample there is ±20 HV certainty.
- Vickers Hardness increases as a function of heat treatment time, with a 21% peak increase at 144 minutes for 500ºC.

CONCLUSION / FUTURE WORK

The optimized Vickers Hardness occurred at 500ºC 144 min heat treatment and yielded a 21% increase in HV. A 20% increase at 1200 min. suggests that heat treatment duration in the 144-1200 min. range will optimize maximum yield strength. In the future, methods of reducing error and more temperature variation should be pursued. Results contrast the expected 30%-35% increase in HV. The cause of this is unknown.

ACKNOWLEDGMENTS

Many special thanks to Dr. Lewys Jones for the use of his code Absolute Integrator, to Dr. Rongmei Niu for performing multiple MP35N HV tests, and to the NHMFL and the NSF REU program for this research opportunity, funded under DMR 1157490.