Differential Scanning Calorimetry Calibration and Heat Capacity

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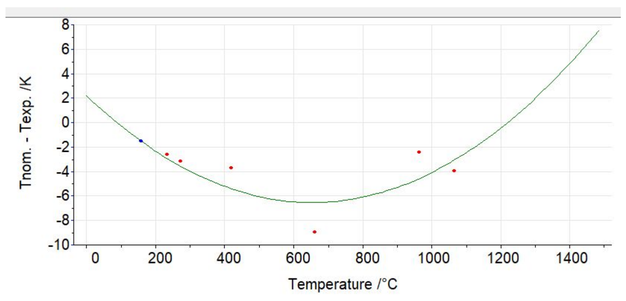
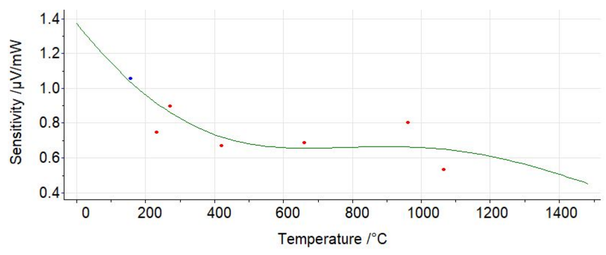
Introduction

High Power Targetry needs materials with specific properties and resistances to high power pulsed proton beam. The material needs to withstand high temperatures, and cannot swell or crack much when hit by the beam . The goal of this project was to calibrate the DSC 404 F3 Pegasus machine by testing various known materials. Then testing for the c_p of novel high entropy alloys(HEAs) and other candidate target materials. HEAs are promising new alloys that could have the potential to be new targets for next generation accelerator facilities..

NETZSCH DSC 404 F3 Pegasus



Melting Point Results From Calibration

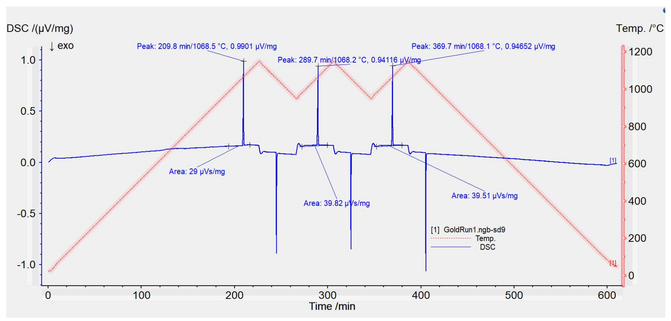


Enthalpy Results From Calibration

Differential Scanning Calorimetry Calibration

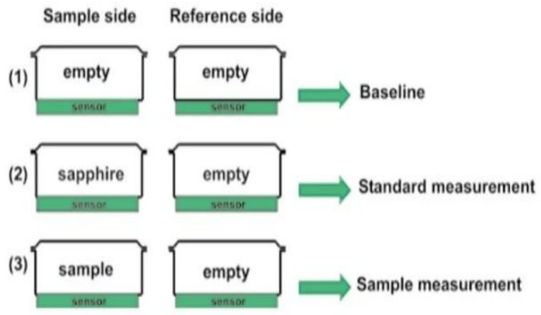
The purpose of the calibration runs was to make sure the DSC machine was outputting the correct data. It was calibrated using the melting points of various metals, as well as the amount of energy needed to melt and crystallize. The results of the calibration were +- 1~3K deviation between the experimental and known melting points. The machine only has a 1.2% error when it comes to calculating the amount of energy needed for a phase transition of these metals. The metals used for calibration were In, Sn, Bi, Zn, Al, Ag, Au. Then the test for c_p calibration was performed with sapphire and the machine reported accurate data

Method for Heat Capacity



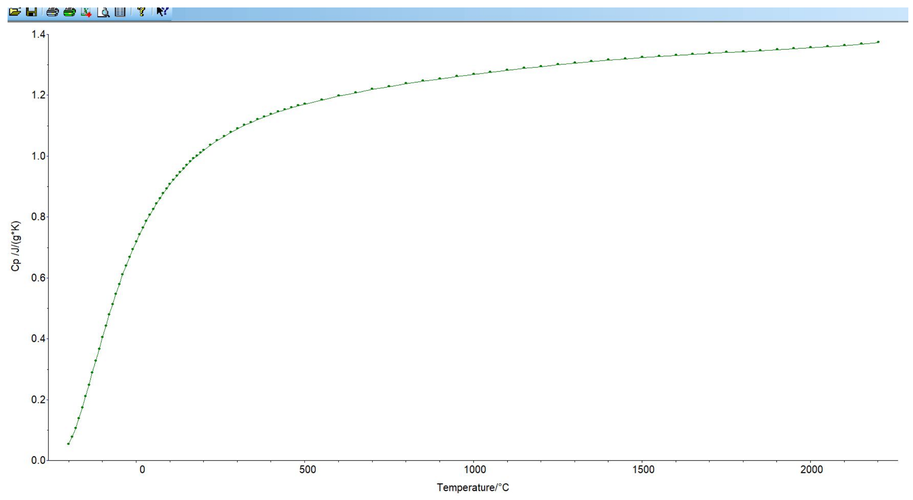
Proteus Analysis Measurement Data Example

To calculate heat capacity, the DSC gathers 3 measurements. The baseline, the standard, and the sample. The baseline is when both crucibles are empty, it is a way to tell if the machine is reading correctly since the output should be close to 0µv/mg. The standard is what will be compared to the sample and is another safeguard to see if the measurement is correct. The standard used at Fermilabs is sapphire. Finally the sample is what is being tested and is the unknown. All of this data is transferred into an analysis software that is capable of calculating the heat capacity from there.



"Three Run Method" Figure from NETZSCH

Heat Capacity of Standard Sample Provided by NETZSCH



Results

The outcomes for the calibration went well as there was no big discrepancies between known and experimental values. This is promising since this means that the DSC is outputting the correct data. Testing for heat capacities with novel materials is currently ongoing.

Conclusion

Overall, the purpose of this project is to test experimental materials that could be used as a target in the beamline. However, learning the behaviors of these materials can be important for other uses as well.

Acknowledgements

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