



**Appalachian
STEM
Academy**
at Oak Ridge



Design and printing of 3D Bonded Magnets

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Appalachian STEM Academy at Oak Ridge 2022

Introduction

Commercial Permanent Magnets

- Motor vehicles utilize more than 20 magnets manufactured through a difficult process.
- Subtractive manufacturing is the traditional process by which these magnets are made.
- Additive manufacturing has the potential to reduce use of cost, time, and most importantly, critical materials containing rare earth elements.

Periodic Table of the Elements

Rare Earth Elements

Background

- Rare Earth elements are utilized in the use and manufacturing of the most powerful magnets.
 - These elements are scarce in the earth's crust and difficult to obtain.
- The process by which we obtain these elements is:
 - Mined from earth → shipped to foreign countries for processing → shipped back to the U.S. for manufacturing.
 - The other option is that we must purchase these elements from foreign countries and have them shipped to us for our use.
- The goal is to find a way to manufacture these magnets with minimal use of these elements without decreasing their effectiveness.
- The use of 3D printed bonded magnets can help us reduce this usage and allow us to recycle these elements, in turn reducing waste.

Materials

- Superconducting Magnet
- BAAM 3D Printer
- Model 2130 Fluxmeter
- Helmholtz Coil
- Caliper
- Electronic Gram Scale?
- Furnace



Method/Process

3D Printing

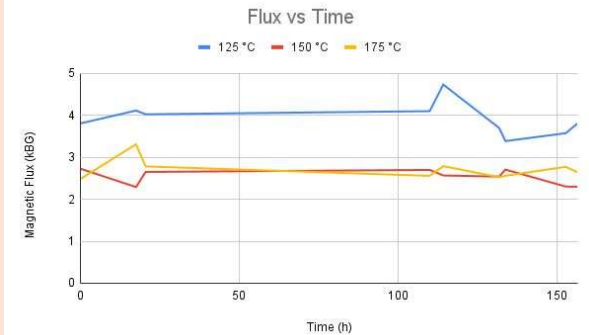
Induction

Flux Test

Heating

Results

Results



- With our results, we expected to see a less than 5% degradation in the magnetic flux.
- This degradation was expected to happen due to the heating of each magnet.
- You can see the linear decrease in the graph above. The largest decrease was seen in the 175°C, which was expected over the time in the furnace.

Conclusions

- All in all, the expected results were shown in the graph above.
- The use of 3D printed NdFeB polymer magnets is a more efficient way to manufacture magnets, rather than the original subtractive manufacturing way.
- This method reduces waste, cost, use of rare earth elements, and makes manufacturing domesticated.

Acknowledgements

Thank you to M. Parans Paranthaman, Ph.D., Annabelle Harding, and James Davis. We appreciate the opportunity provided to us by Oak Ridge National Laboratory, Oak Ridge Associated Universities, and the Appalachian Regional Commission.

After each flux test, each sample was heated at temperatures corresponding with the graph in the results section. After heat treating each sample, the mass was measured, volume was calculated.