High-Pressure Laser Diode Floating Zone and the Synthesis of $NbTiSi_x$

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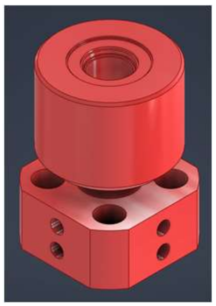
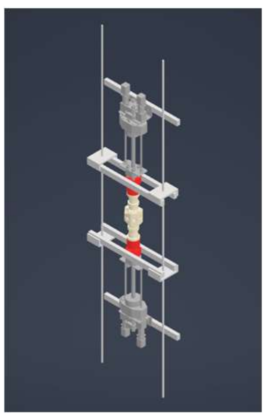
Introduction

- We present the design of the High-Pressure Laser Diode Floating Zone furnace (HPLDFZ) and the various custom designed parts to allow for the operation of the instrument to be secure
- We also present how the addition of silicon to niobium alloys improve their oxidation resistance at temperatures up to 1000˚C.

Results: HPLDFZ

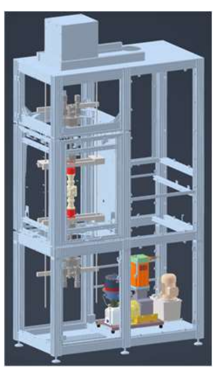
- The HPLDFZ adapter functions as the secure connection between the pulling drives and the high-pressure chamber
- It was modeled from previous renders and the dimensions were determined using the high-pressure chamber and the pulling drives as reference



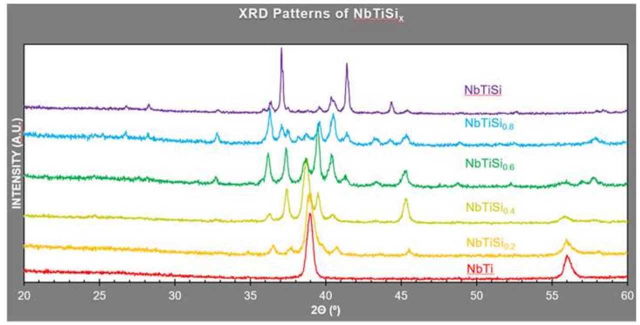


- To the left are the pulling drives, high-pressure chamber, HPLDFZ adapters, and frame
- The HPLDFZ adapter successfully connected both the upper and lower pulling drives to the high-pressure chamber, which are all connected to the frame

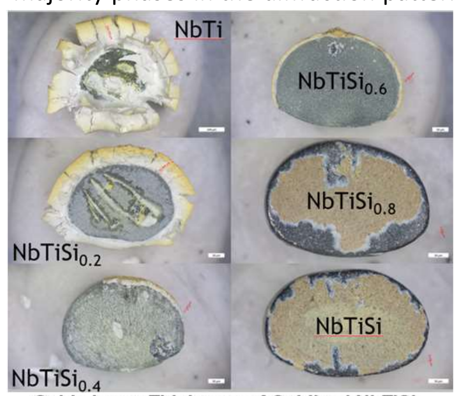
- An expanded view of the entire assembly of the HPLDFZ including the:
  - HPLDFZ Adapter
  - High-Pressure Chamber
  - Pulling Drives
  - High-Pressure Gas Compressor
  - Bomb-Proof Enclosure (outer panels removed)

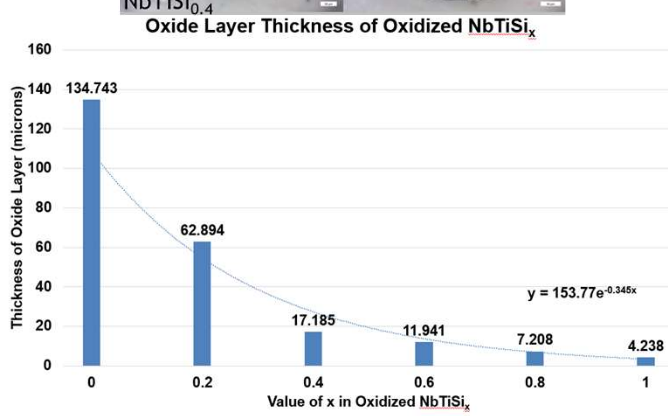


Results: $NbTiSi_x$



As more silicon is added to the pure NbTi phase, binary Nb_5Si_3, Nb_3Si, and $TiSi_2$ phases start to become the majority phases in the diffraction pattern





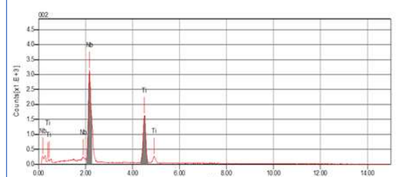
The oxidation trend is supported by micron measurements on a ZIESS Stereo Microscope Stemi 508

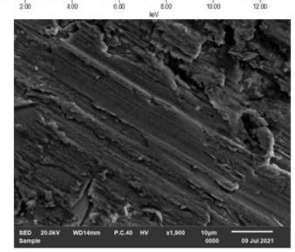
Conclusions

- The inner components successfully connect to each other via the HPLDFZ Adapter
- More designs will need to be designed to properly secure the frame for safe usage of the instrument
- The addition of silicon to niobium titanium alloys drastically increases their oxidation resistance at temperatures up to 1000⁰ C
- The addition of silicon to niobium titanium alloys forms Nb_5Si_3, Nb_3Si, and $TiSi_2$ phases

Future Work

Safety interlocks that function as kill switches will be added to the HPLDFZ and more parts will be designed and added to the supporting frame holding the pulling drives, high-pressure chamber, and HPLDFZ adapters





A scanning electron microscope will be used to verify the chemical composition of the alloy samples. Nanoindentation will also be used to test the mechanical strength of the materials post box furnace oxidation.

Acknowledgments:

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References:

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