Lab Exercise: Powder-Milling Process and Analysis of a Mo-V-Si-B Alloy

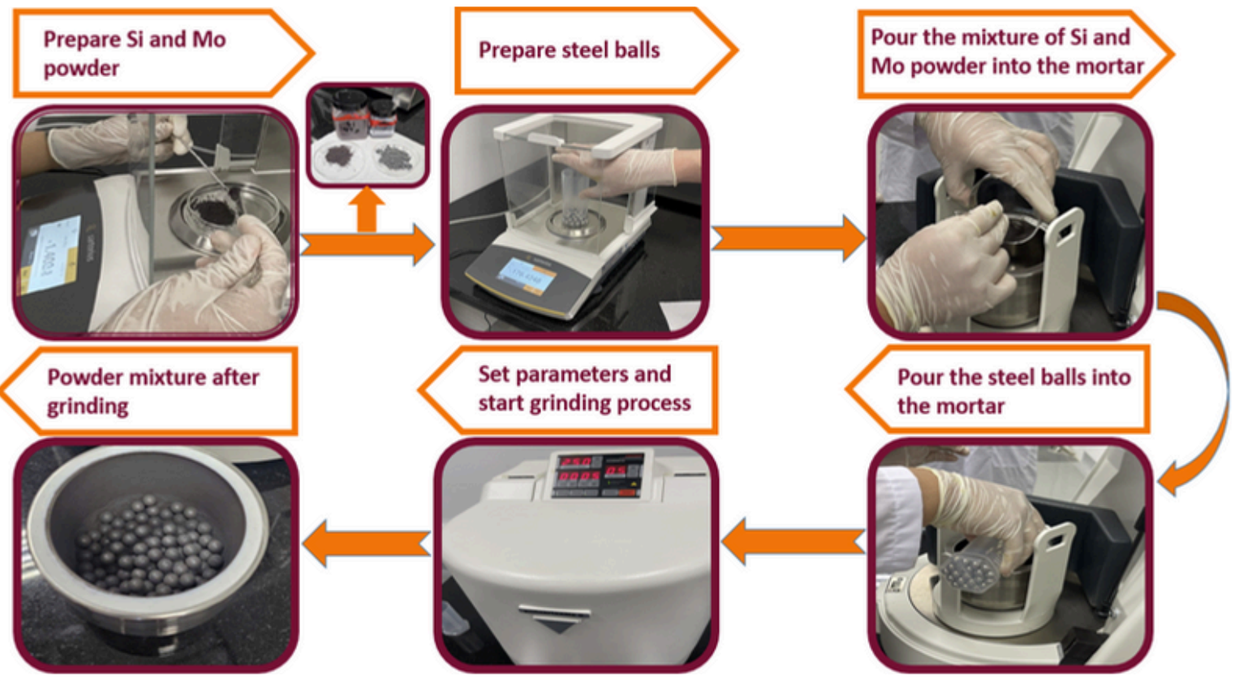
Le Dinh Phi[1], Le Quoc Anh Kiet[1], Nguyen Minh Dung[1] ,Nguyen Son Tung[1], Nguyen Ngoc Thuy Khanh[1], Huynh Quang Thien[1], Huynh Quang Phu[1]

Supervisor: Manja Krueger[2] , Georg Hasemann[2]

[1]Vietnamese-German University, Faculty of Engineering, Cluster 1, Binh Duong, Viet Nam

[2]Otto-von-Geuricke Universität Magdeburg, Institute of Materials, Technology and Mechanics, Universtätplatz 2, Magdeburg 39106, Germany

Story behind: Power metallurgy explores a different path to produce industrial component without reaching melting temperature. In this lab, VGU students explored basic powder milling and complete procedure of powder analysis. These include XRD data analysis, particle size measurement and SEM observations. On the last lunch, Dr. Georg Hasemann was forced to have rice vermicelli with fried tofu and shrimp paste.



Sample Preparation

The lab course introduced the first preparations and the steps of this process with a Molybdenum-Silicon-based powder mixture

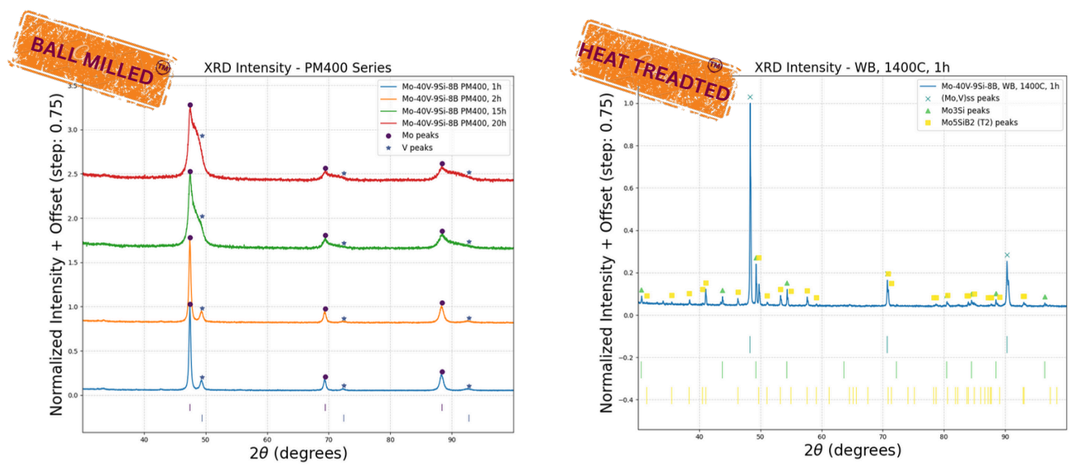
The available specimens of Mo-40V-9Si-8B milled for 1h, 2h, 15h and 20h was identified by XRD for comparison


Molybdenum Powder


Silicon Powder

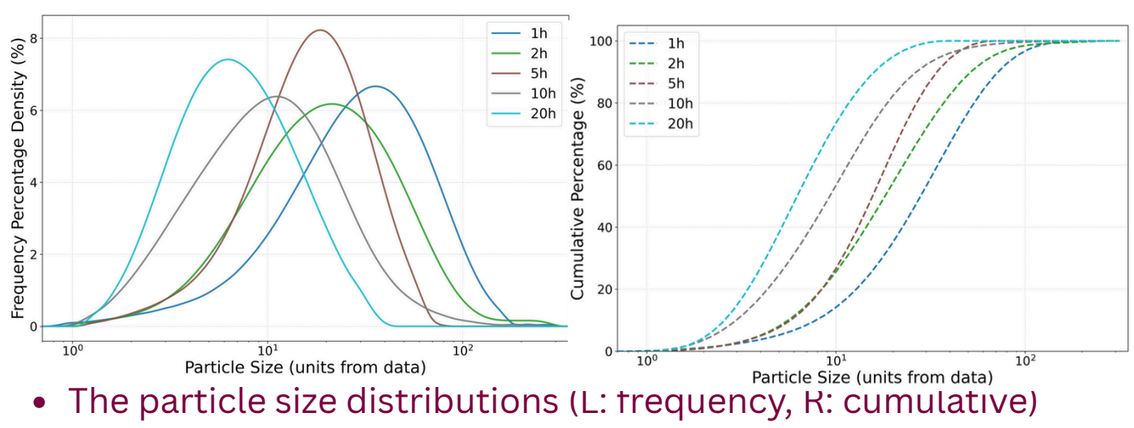

Mo-40V-9Si-8B Solid

XRD Results



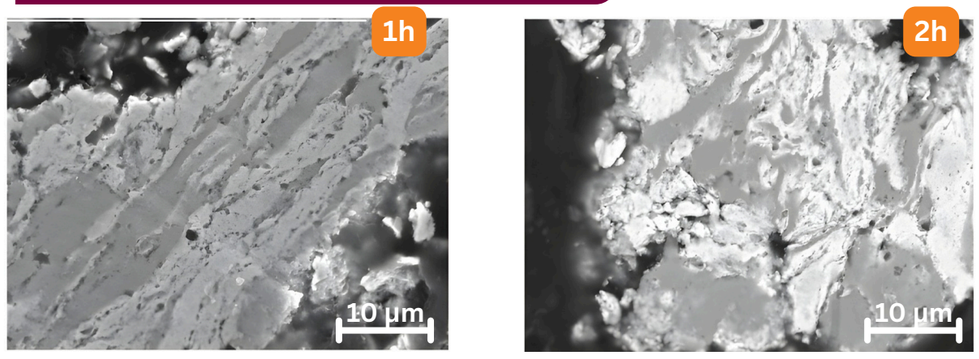
- Ball milled: Vanadium substitution into Molybdenum lattice
  - Pure Vanadium slowly disappear
  - $Mo(V)_{ss}$ phase increases due to mechanical force
- Heat treated: Precipitation of $Mo(V)_3Si$, $Mo(V)_5SiB_2$ from a super saturated Mo phase

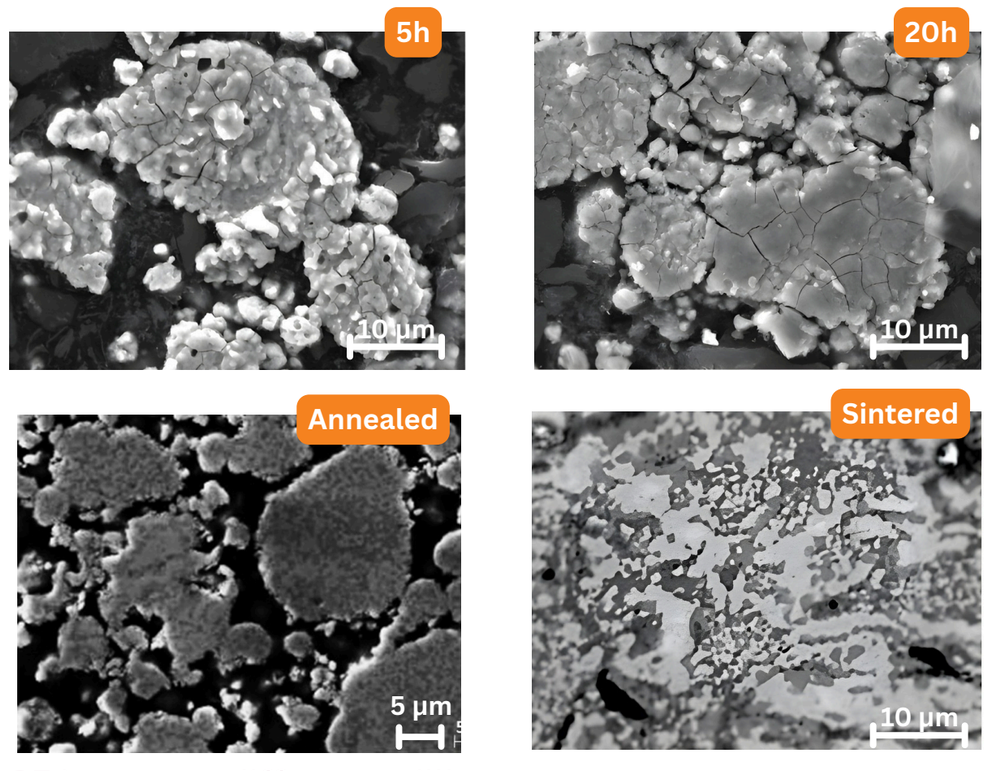
Particle Size Analysis



- The particle size distributions (L: frequency, R: cumulative) decrease with increasing milling time.

SEM Analysis





SE images at different milling stages

- At 1-2 hour of milling, the material exhibits distinct lamellar microstructures
- 5-hour and 20-hour milling samples undergo significant oxidation due to humidity at VGU
- $Mo(V)_{ss}$-$Mo(V)_3Si$-$Mo(V)_5SiB_2$ three-phase microstructure is formed after annealing and sintering

Conclusion

- The lab course provides a first insight of the preparation and milling process of a Mo-V-Si-B alloy
- The XRD shows the change of difference lattices with disappearing of Vanadium and raising of Mo(V)ss
- The particle size was investigated as a function of the milling time
- The SEM analysis gives information about the microstructures and morphology of processed powder

MSI intake 2024
29th May 2025