



## **Study of Phase-Transformation Behavior in Additive Manufacturing of Nitinol Shape Memory Alloys by In Situ TEM Heating**

**Yang, Yi-Chieh; Zhu, Jia-Ning; Sneppen, Thor Bjerregård; Bastos da Silva Fanta, Alice; Popovich, Vera; Jinschek, Joerg R.**

*Publication date:*  
2023

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Yang, Y-C., Zhu, J-N., Sneppen, T. B., Bastos da Silva Fanta, A., Popovich, V., & Jinschek, J. R. (2023). *Study of Phase-Transformation Behavior in Additive Manufacturing of Nitinol Shape Memory Alloys by In Situ TEM Heating*. Abstract from 3rd Asia-Pacific International Conference on Additive Manufacturing, Sydney, New South Wales, Australia.

---

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Study of Phase-Transformation Behavior in Additive Manufacturing of Nitinol Shape Memory Alloys by In Situ TEM Heating

Yi-Chieh Yang<sup>1</sup>, Jia-Ning Zhu<sup>2</sup>, Thor Bjerregård Sneppen<sup>3</sup>, Alice Bastos da Silva Fanta<sup>1</sup>, Vera Popovich<sup>2</sup> and Joerg R. Jinschek<sup>1\*</sup>.

- <sup>1</sup>. National Center for Nano Fabrication and Characterization (DTU Nanolab), Technical University of Denmark (DTU), Kgs. Lyngby, Denmark
- <sup>2</sup>. Department of Materials Science and Engineering, Delft University of Technology, Delft, The Netherlands
- <sup>3</sup>. Department of Mechanical Engineering, Technical University of Denmark (DTU), Kgs. Lyngby, Denmark

\* Corresponding author: jojin@dtu.dk

Reversible martensitic transformation, a diffusionless solid-solid phase transition, gives NiTi (Nitinol) alloys shape memory effect (SME) and superelasticity with several-percent recoverable strains. Because of these attractive properties, NiTi alloys are widely applied in actuators, sensors, and dampers. With the recent advent of laser powder bed fusion (L-PBF) additive manufacturing (AM), NiTi with complex geometry can be fabricated by the near-net-shape manufacturing. Since L-PBF processes involve rapid heating/cooling rates, steep thermal gradients and complex histories, locality in NiTi parts exhibits heterogeneity, which dramatically affects their functional properties. Therefore, an in-depth understanding of the correlation between thermal process parameters and structural variations is essential for material design.

Thus, to capture the connections between phase transformation and the local inhomogeneity, TEM samples from different locations in the melt pool area were prepared and placed on a MEMS-based microheater for *in-situ* heating transmission electron microscopy (TEM) experiments. A higher phase transformation resistance was shown at the melt pool boundaries, due to the fine cellular structure and high-density of dislocations. Our results indicate the ability to apply *in-situ* TEM heating experiments to study microstructural transformations for further optimizing process parameters in (additive) manufacturing.