Processing of thin Magnesium Wires

Institute of Material and Process Design

Merle Braatz[1], Maria Nienaber[1], Jan Bohlen[1] and Noomane Ben Khalifa[1,2]

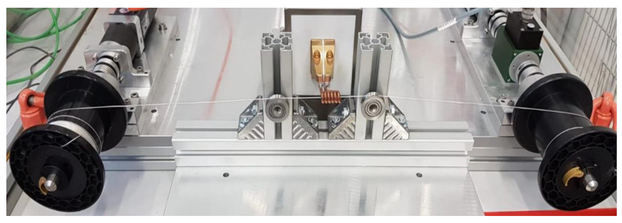
[1]Institute of Material and Process Design, Helmholtz Zentrum Hereon
[2]Institute for Production Technology and Systems, Leuphana Universität Lüneburg

Helmholtz-Zentrum hereon

Motivation

Wire Extrusion Approach

- High flexibility in die profiles and diameters
- Hot massive forming with high extrusion ratios in one step
- Different alloy-dependent effects on wire properties



Flexible Wire Drawing Approach

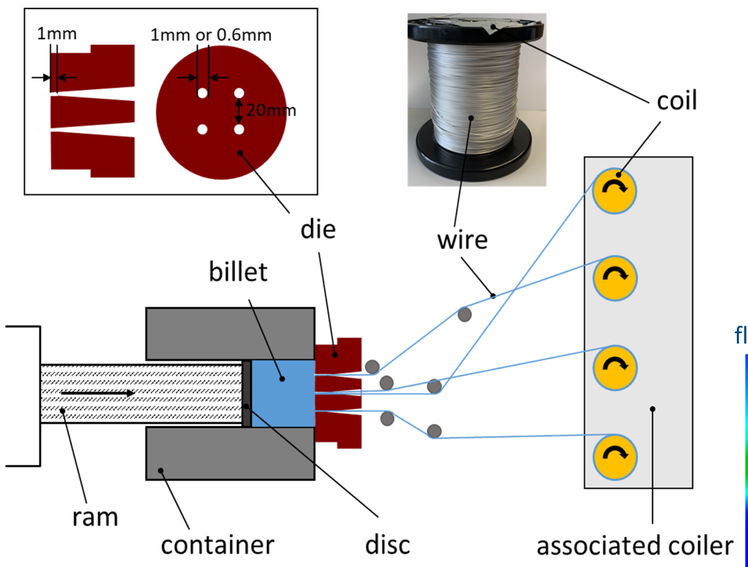
- High- and low-speed applications
- Conventional cold drawing (with die, surface impact)
- Dieless wire drawing (local heat impact, no die impact or lubrication)
- Different alloy-dependent effects on wire properties

Sustainable applications with large potential

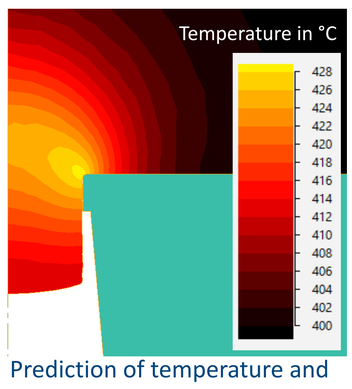
- Biodegradable products, e.g. ureteral or cardiovascular stents
- Input material for e.g. Wire Arc Additive Manufacturing

Wire processing routes and Simulation

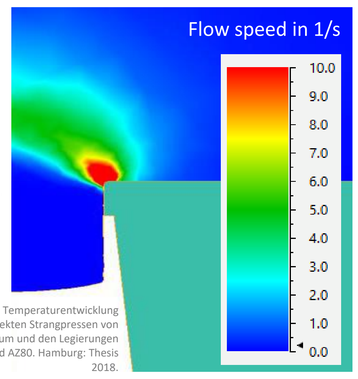
Direct Wire Extrusion



Nienaber, M., Yi, S., Kainer, K. U., Letzig, D., & Bohlen, J. (2020). On the Direct Extrusion of Magnesium Wires from Mg-Al-Zn Series Alloys. *Metals*, *10*(9), 1208.

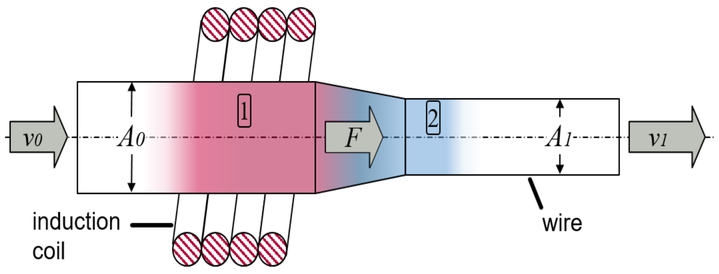


Prediction of temperature and flow stress in extrusion simulation

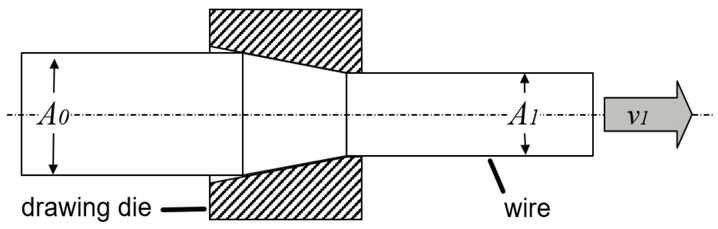


Isakovic, J.: Temperaturentwicklung im direkten Strangpressen von Magnesium und den Legierungen AZ31 und AZ80. Hamburg: Thesis 2018.

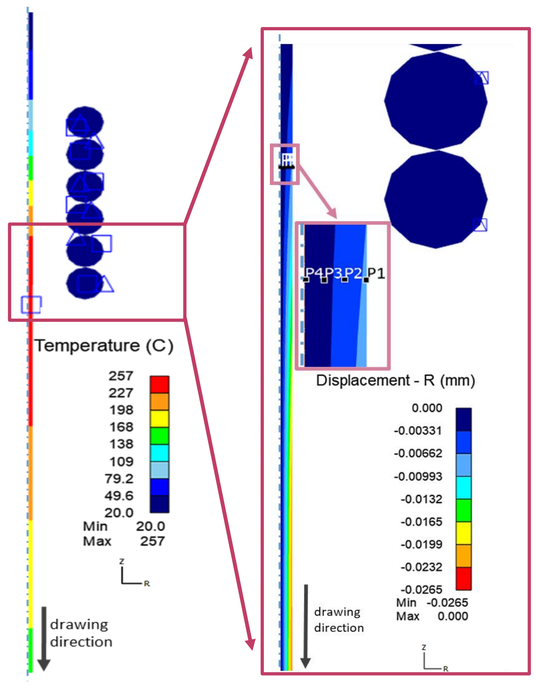
Dieless Wire Drawing



Conventional Wire Drawing



Braatz, M., Bohlen, J., & Ben Khalifa, N. (2022). Process Stability and Reproducibility of the Dieless Drawing Process for AZ31 Magnesium Wires. *Key Engineering Materials*, *926*, 389-400.



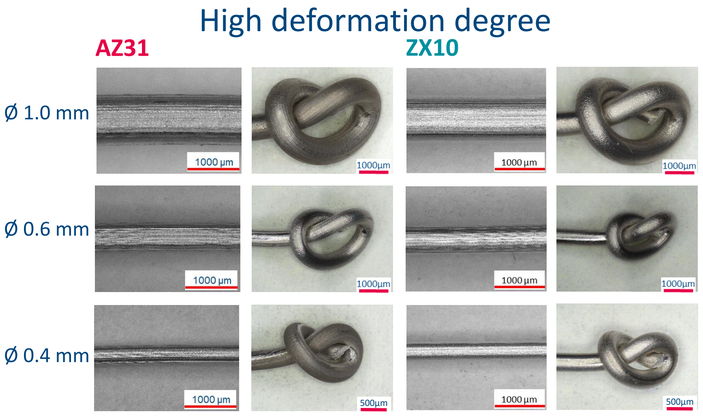
Prediction of temperature and diameter in dieless wire drawing simulation

Braatz, M., Bohlen, J., & Ben Khalifa, N. (2023, August). Experimental and Numerical Investigation of the Forming Zone in Dieless Wire Drawing Process of Thin Biometallic Wires. In *International Conference on the Technology of Plasticity* (pp. 479-490). Cham: Springer Nature Switzerland.

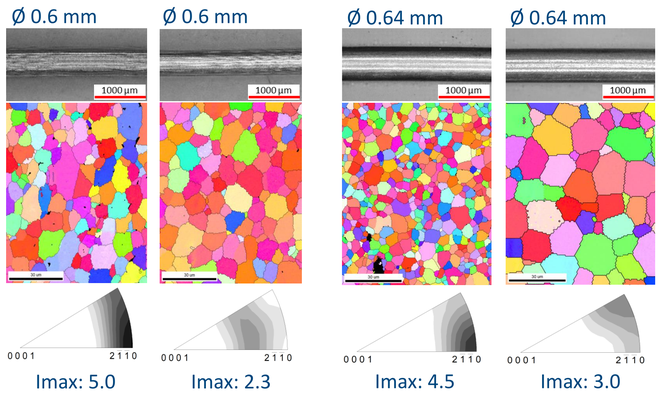
Process-Properties-Correlation Development

Direct wire extrusion

High deformation degree



Direct extruded

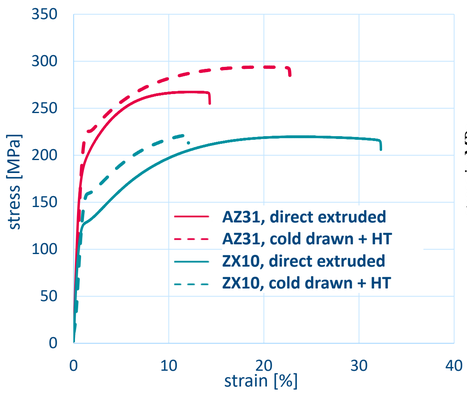


Cold drawn plus HT

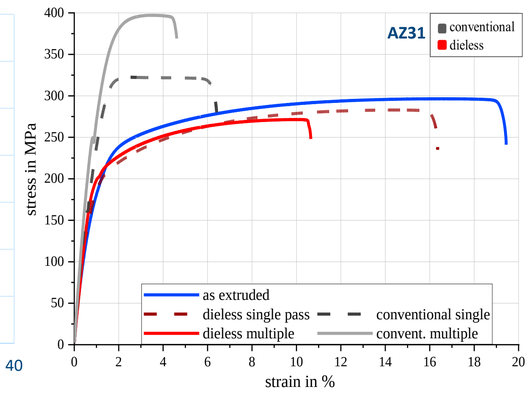
Nienaber, M., Braatz, M., Khalifa, N. B., & Bohlen, J. (2022). Property profile development during wire extrusion and wire drawing of magnesium alloys AZ31 and ZX10. *Materials & Design*, *224*, 111355.

Extrusion vs. conventional drawing vs. dieless drawing

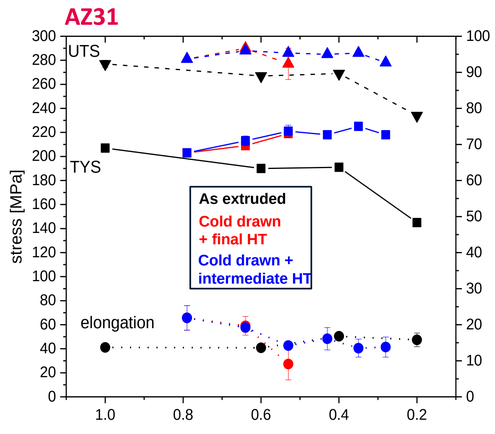
Mechanical Properties

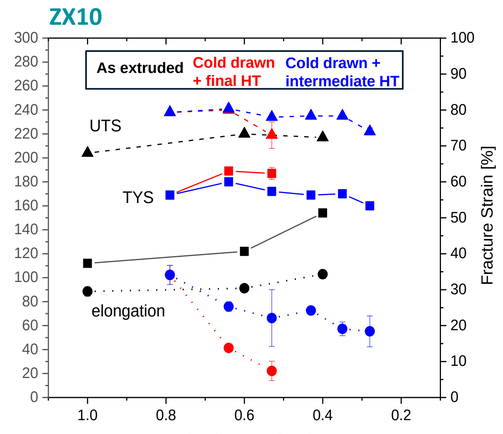


Nienaber, M., Braatz, M., Khalifa, N. B., & Bohlen, J. (2022). Property profile development during wire extrusion and wire drawing of magnesium alloys AZ31 and ZX10. *Materials & Design*, *224*, 111355.



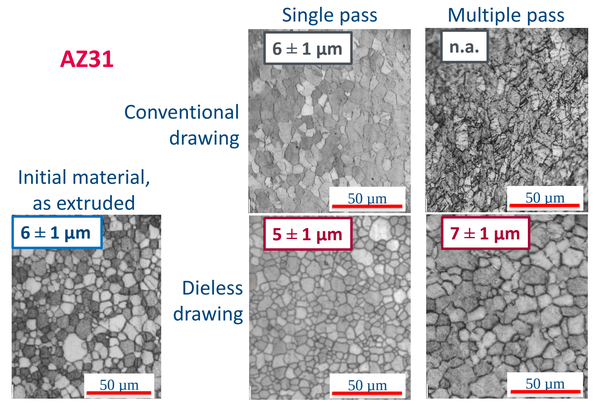
Braatz, M., Bohlen, J., & Ben Khalifa, N. (2022). Process Stability and Reproducibility of the Dieless Drawing Process for AZ31 Magnesium Wires. *Key Engineering Materials*, *926*, 389-400.





Dieless wire drawing

Microstructure



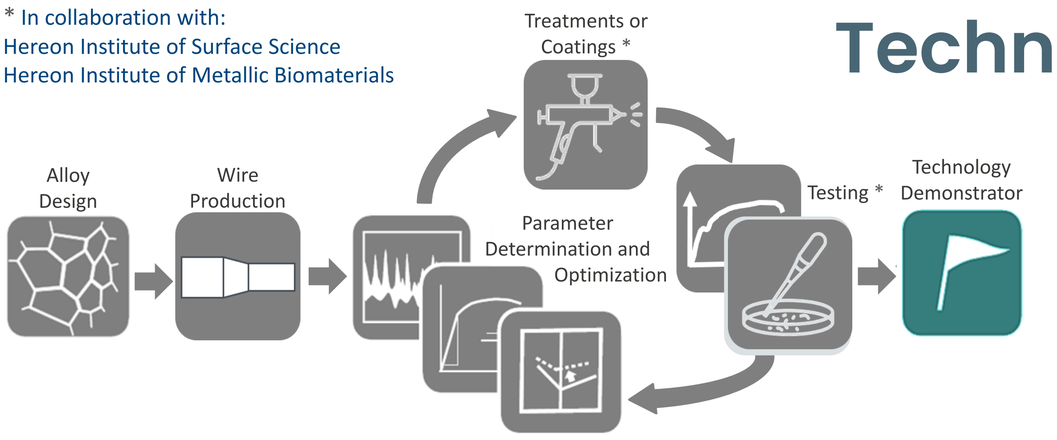
Braatz, M., Bohlen, J., & Ben Khalifa, N. (2022). Process Stability and Reproducibility of the Dieless Drawing Process for AZ31 Magnesium Wires. *Key Engineering Materials*, *926*, 389-400.

Temperature and diameter simulation

Braatz, M., Bohlen, J., & Ben Khalifa, N. (2023, August). Experimental and Numerical Investigation of the Forming Zone in Dieless Wire Drawing Process of Thin Biometallic Wires. In *International Conference on the Technology of Plasticity* (pp. 479-490).

Technology Transfer

* In collaboration with:
Hereon Institute of Surface Science
Hereon Institute of Metallic Biomaterials



- ➔ Development of fine wires for biomedical or microforming applications
- ➔ Further fundamental understanding of forming mechanisms, property profile development and mechanical material behavior

Prototype of a Mg-based biodegradable ureteral stent (Courtesy: Hydrumedical)

LEUPHANA UNIVERSITÄT LÜNEBURG

Helmholtz-Zentrum **Hereon** • Max-Planck-Straße 1 • 21502 Geesthacht I Germany • T +49 4152 87-0 • contact@hereon.de • www.hereon.de
Contact: Merle Braatz • T +49 4152 87-2719 • merle.braatz@hereon.de I Maria Nienaber • T +49 4152 87-1967 • maria.nienaber@hereon.de