Characterization methodology for thin materials in the field of e-mobility

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Chair of Metal Forming and Casting

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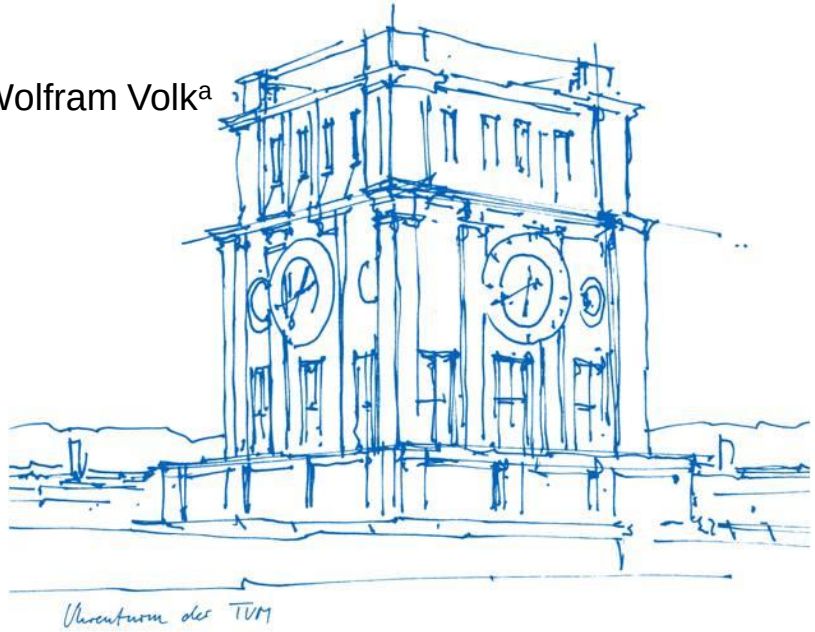

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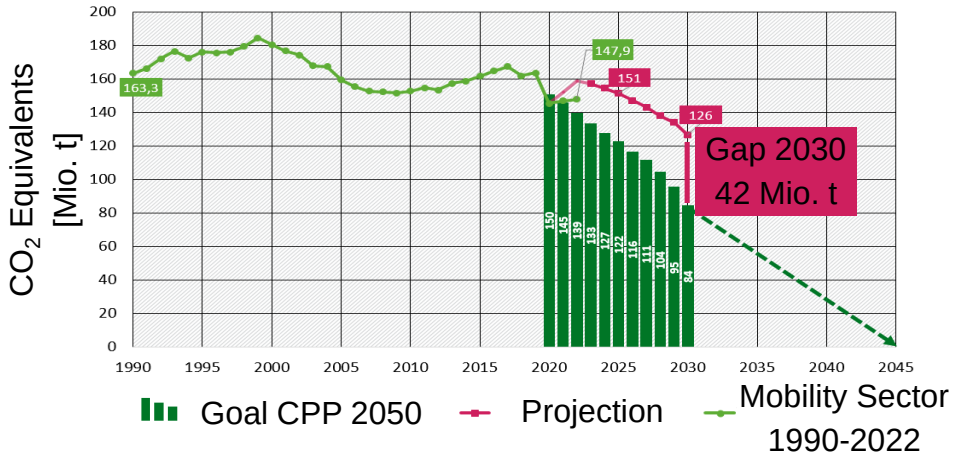
Motivation and Introduction

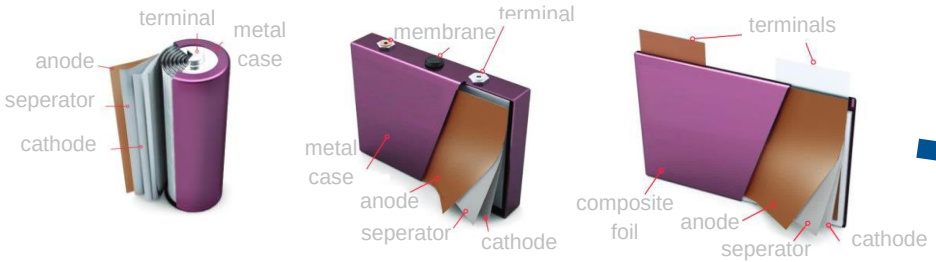
- 40 % - Reduction of CO_2 – emissions in the mobility sector is required to reach the goals of the Climate Protection Plan 2050

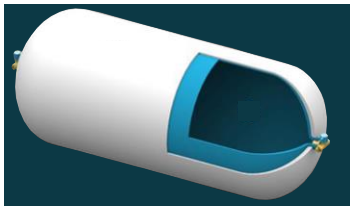
- Mobility is the only big sector (energy, industry, buildings, mobility and agriculture) were almost no reduction of the CO_2 – emissions was reached between 1990 and 2019

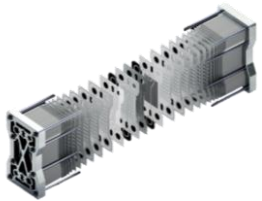


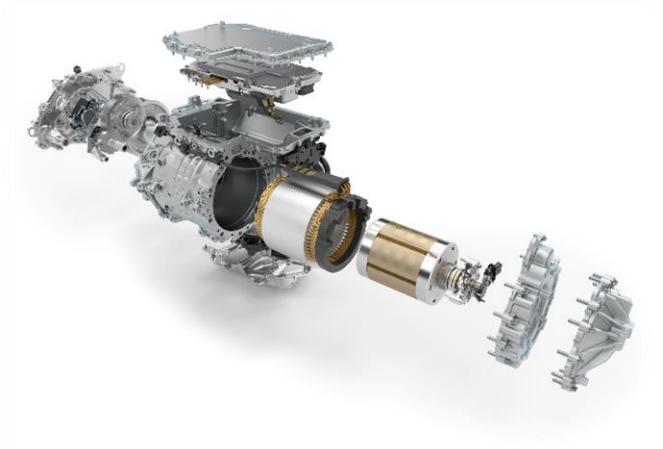
Source: [UBA2023]

Motivation and Introduction







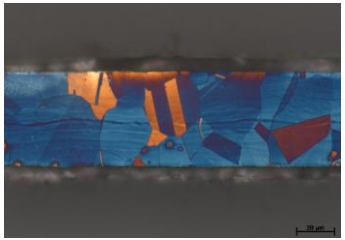
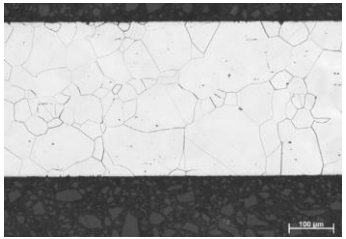


Material parameters are required for those materials!

Source: [Feintool]

Investigated Materials

- 4 different materials are investigated

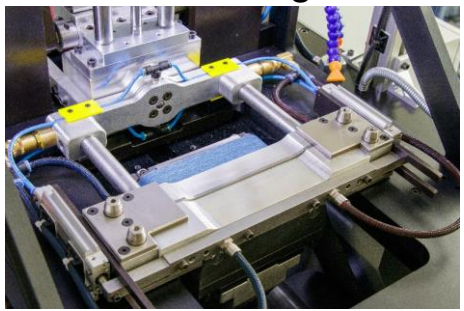
AA1085 15 µm	1.4404 50 µm	1.4404 75 µm	FeSi24 350 µm
			
Battery	Bipolarplate	Bipolarplate	Electrical engine

Microstructure makes specimen processing difficult

Source: [WEISS17]

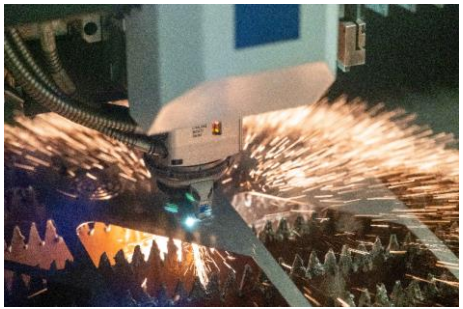
Investigated Manufacturing Processes

Grinding



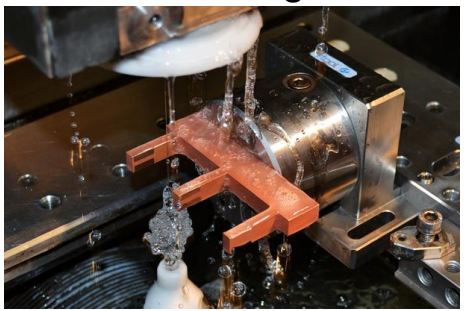
[1]

Laser Cutting



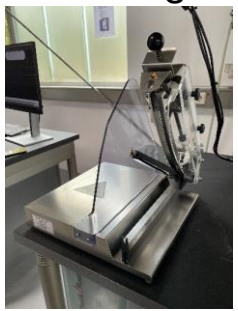
[2]

Eroding



[3]

Shear Cutting



[4]

Source: [1] utg, [2] TRUMPF Group, [3] Willi Weber, [4] ZwickRoell

Different Specimen Geometries

DIN EN ISO50125

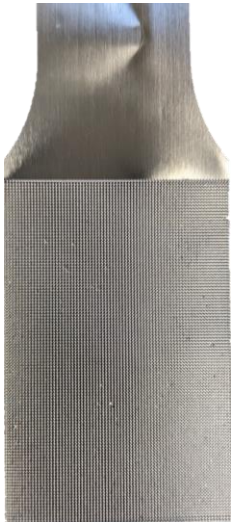
Form H

Grinding, Laser Cutting, EDM

Shear Cutting

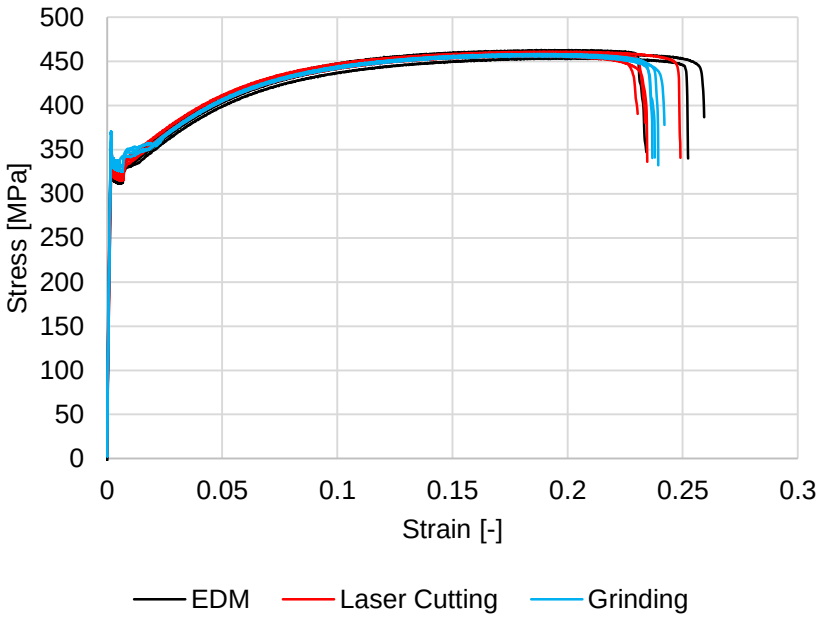
Experimental Setup

- ZwickRoell Z150 with LaserXtens
- Aramis SRX
- Strain rate AA1085:
  - 0.0004 1/s constant
- Strain rate other materials:
  - 0.00025 1/s in the elastic regime
  - 0.00292 1/s in the plastic regime

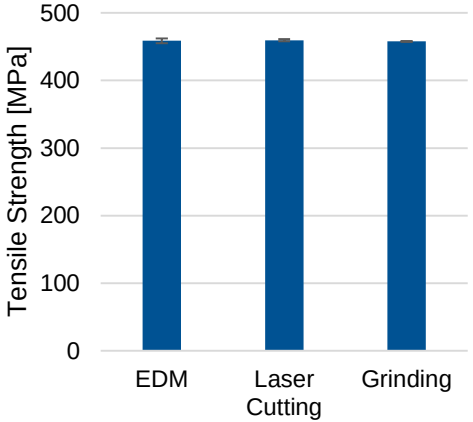


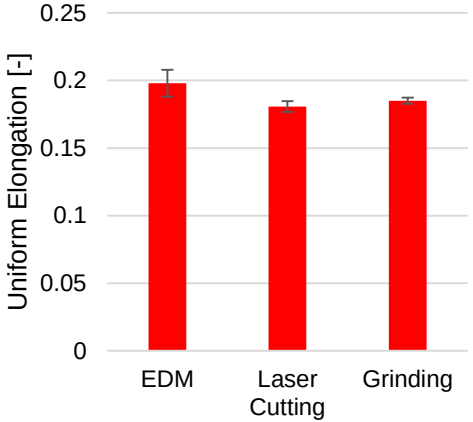
FeSi24 – 350 µm

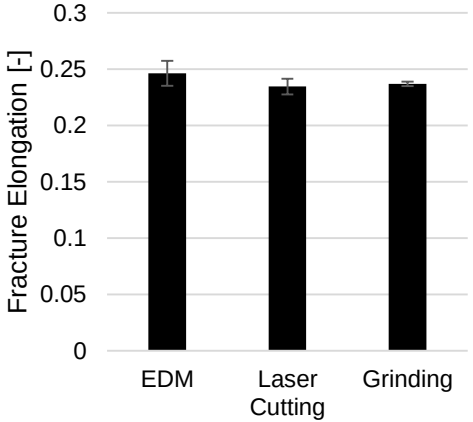
- Shear cutting was not possible due to the thickness of 350 µm
- In general, only small differences in between the different manufacturing processes



FeSi24 – 350 µm



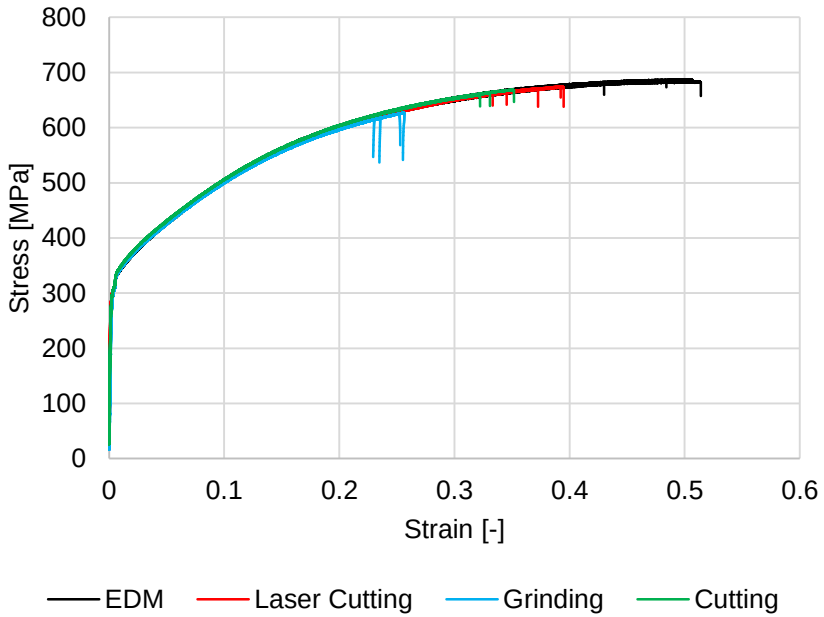




Different process have only little influence on the obtained parameters

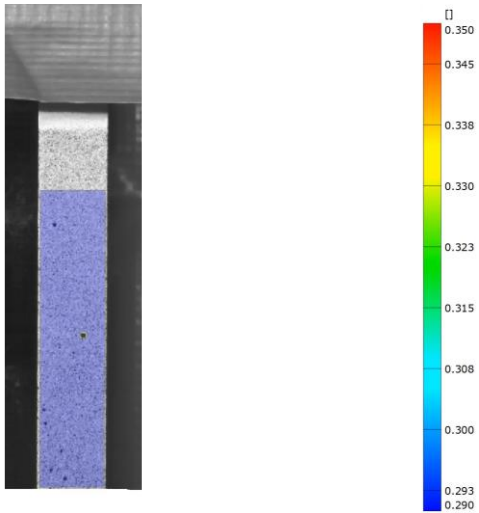
1.4404 – 75 µm

- Large differences in between the different manufacturing processes
- EDM leads to the „best“ results

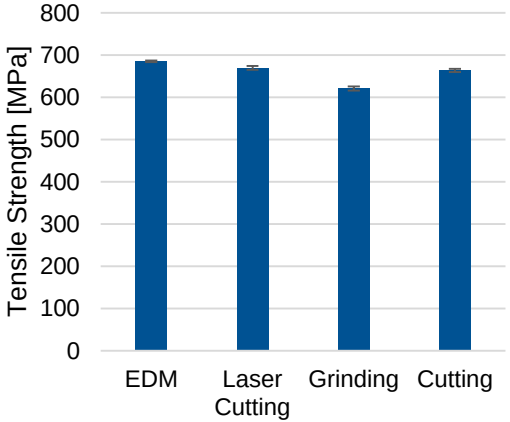


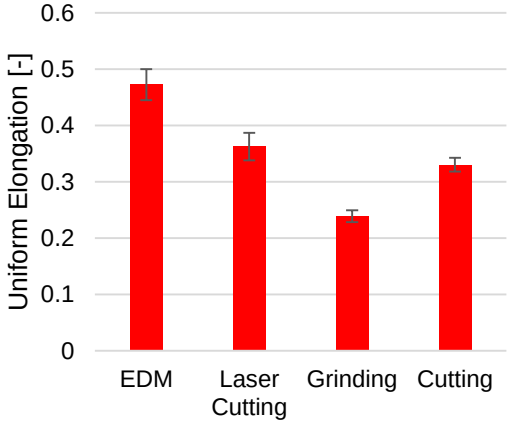
1.4404 – 75 µm

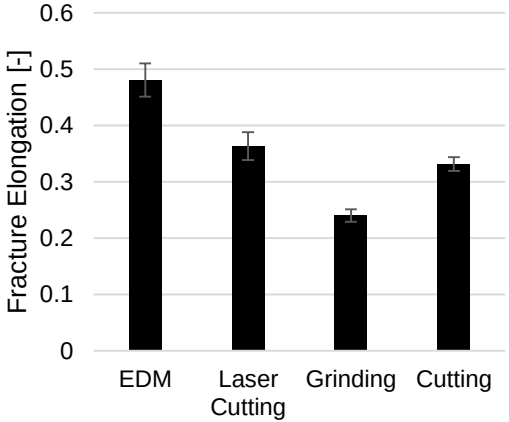
- Differences in the results come from edge cracks which are visible using DIC
- Material is very sensitive to edge cracks



1.4404 – 75 µm



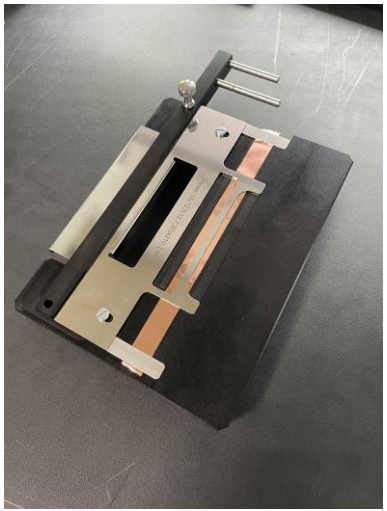


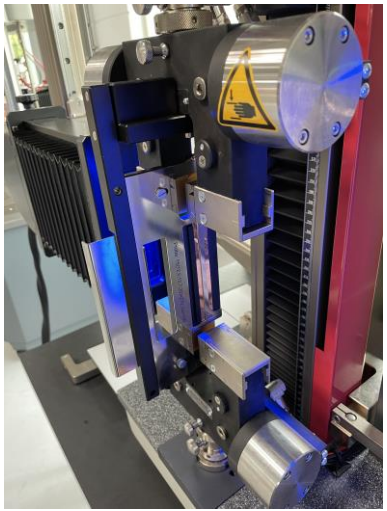


Different process have big influence on the obtained parameters

ZwickRoell – Mounting Helper

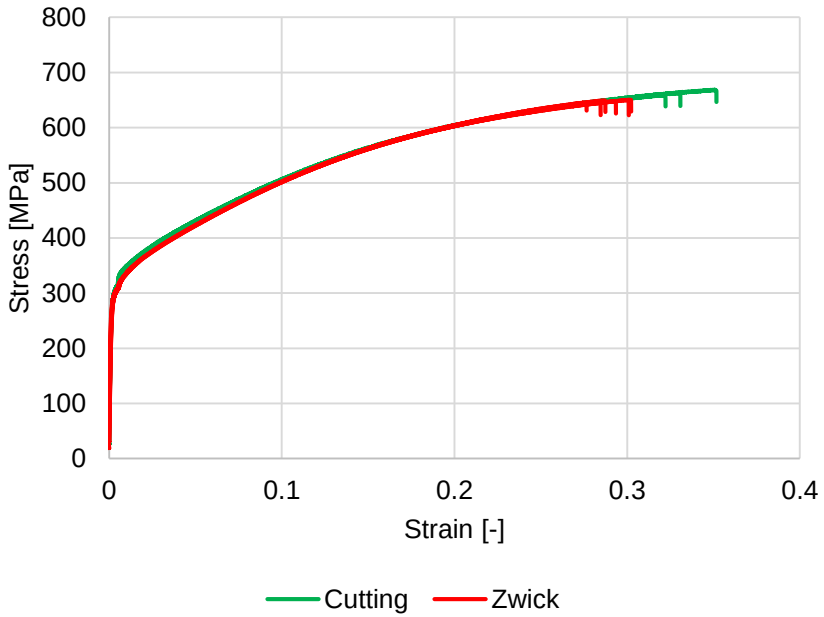
- Special clamping aid for thin materials by ZwickRoell
- Avoidance of wrinkles and slanted specimen mounting





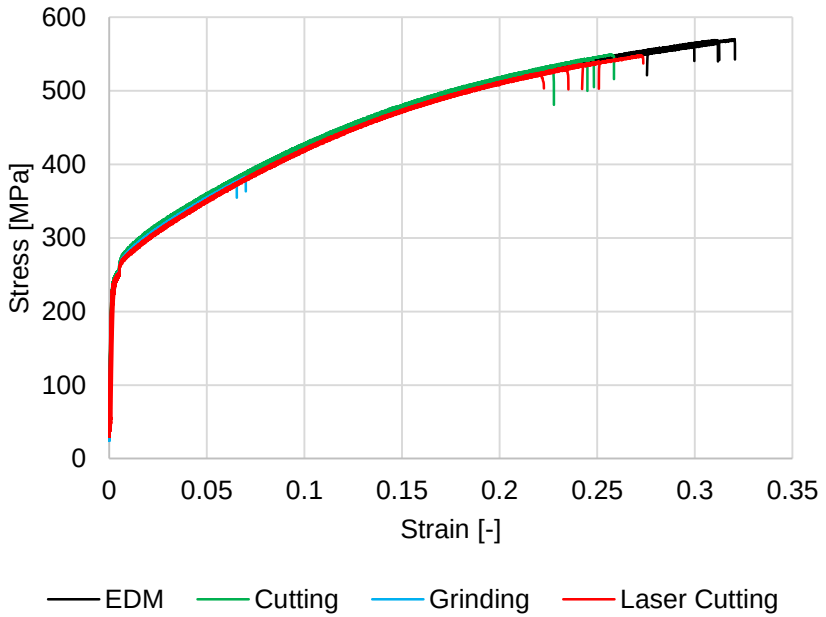
1.4404 – 75 µm

- Differences between the mounting helper and the specimen mounting by hand is small
- Experiments were carried out by the utg and ZwickRoell

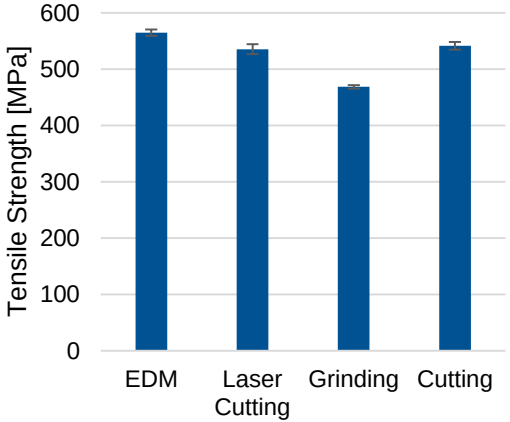


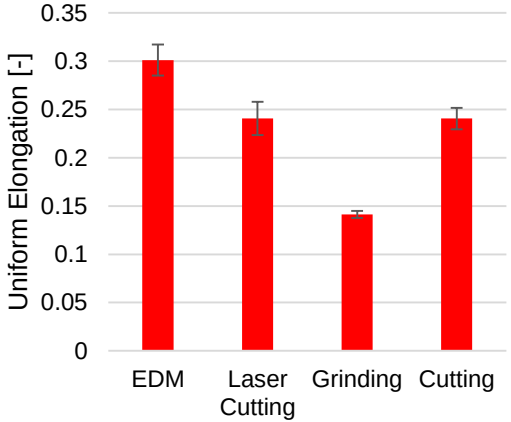
1.4404 – 50 µm

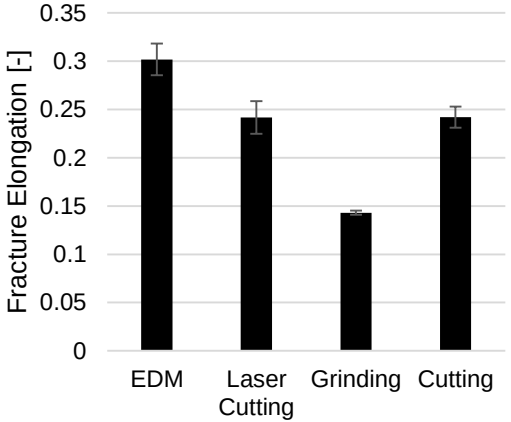
- Large differences in between the different manufacturing processes
- Grinding is not suited for this material and thickness
- Laser cutting and cutting are quite similar
- EDM leads to the „best“ results



1.4404 – 50 µm



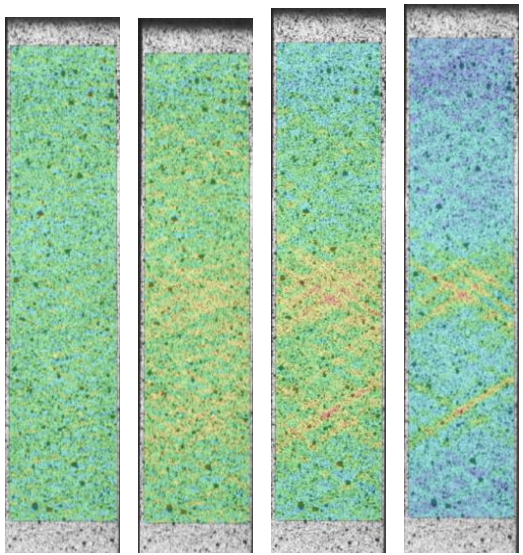




Different process have big influence on the obtained parameters

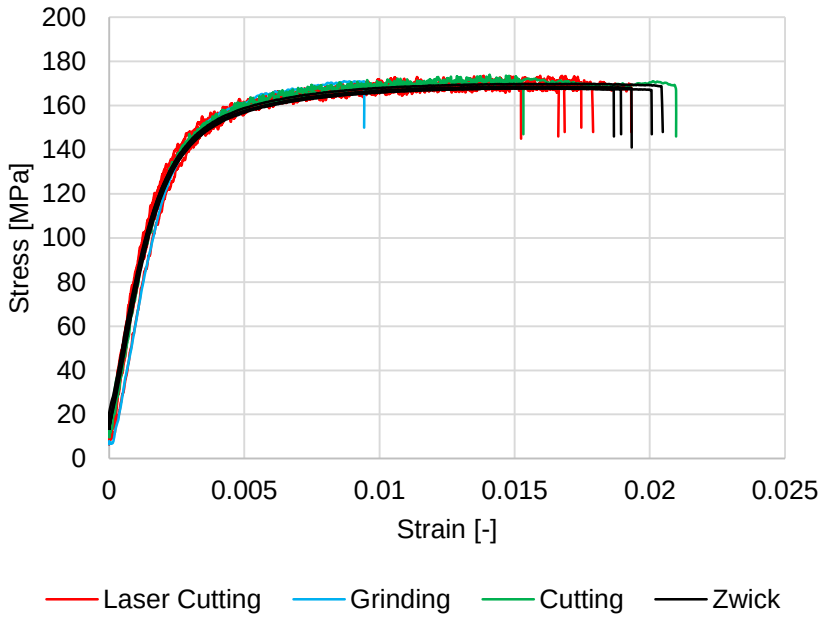
AA1085 – 15 µm

- Material shows „Lüders“-bands
- Material behaviour is very inhomogeneous until fracture

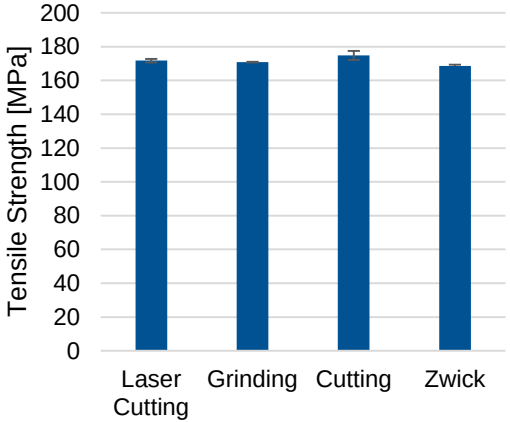


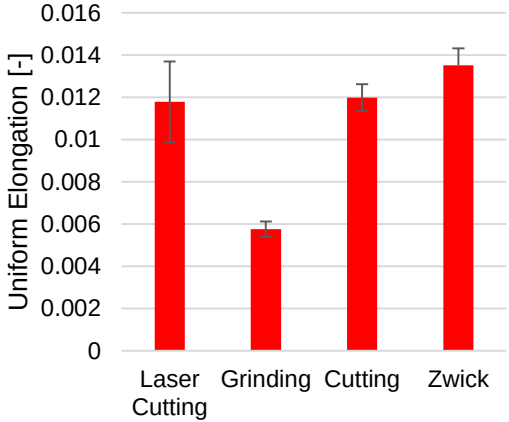
AA1085 – 15 µm

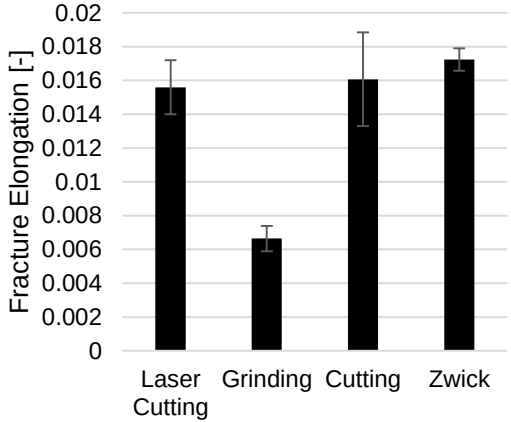
- Large differences in between the different manufacturing processes
- Grinding is not suited for this material and thickness
- Laser cutting and cutting are quite similar
- ZwickRoell used same specimens in combination with the mounting helper
- EDM was not possible



AA1085 – 15 µm







- **Different process have big influence on the obtained parameters**
- **Mounting helper reduced scattering of the results**

Conclusion

- Suitability to manufacture the specimens:

Material	Grinding	Laser Cutting	EDM	Cutting
FeSi24 – 350 µm	++	++	++	n.p.
1.4404 – 75 µm	--	+	++	+
1.4404 – 50 µm	--	+	++	+
AA1085 – 15 µm	--	++	n.p.	++

Conclusion

- Other aspects:

Criteria	Grinding	Laser Cutting	EDM	Cutting
Process Time	+	+	--	++
Cost	+	-	--	++
Accuracy	-	+	++	++

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Thank you.

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Sources

[UBA2023]: Klimaschutz im Verkehr, URL: https://www.umweltbundesamt.de/themen/verkehr/klimaschutz-im-verkehr#ziele

[WEISS17]: Weiss, H.; Leuning, N.; Steentjes, S.; Hameyer, K.; Andorfer, T.; Jenner, S. and W.Volk (2017): Influence of shear cutting parameters on the electromagnetic properties of non-oriented electrical steel sheets, In: *Journal of Magnetism and Magnetic Materials,* doi: http://dx.doi.org/10.1016/j.jmmm.2016.08.002