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Considering Scaling Aspects in Interface Design for Adhesion-Promoting Laser Structures in Polymer–Metal Hybrids

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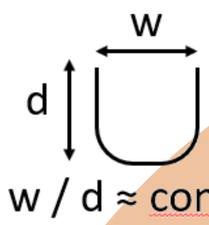
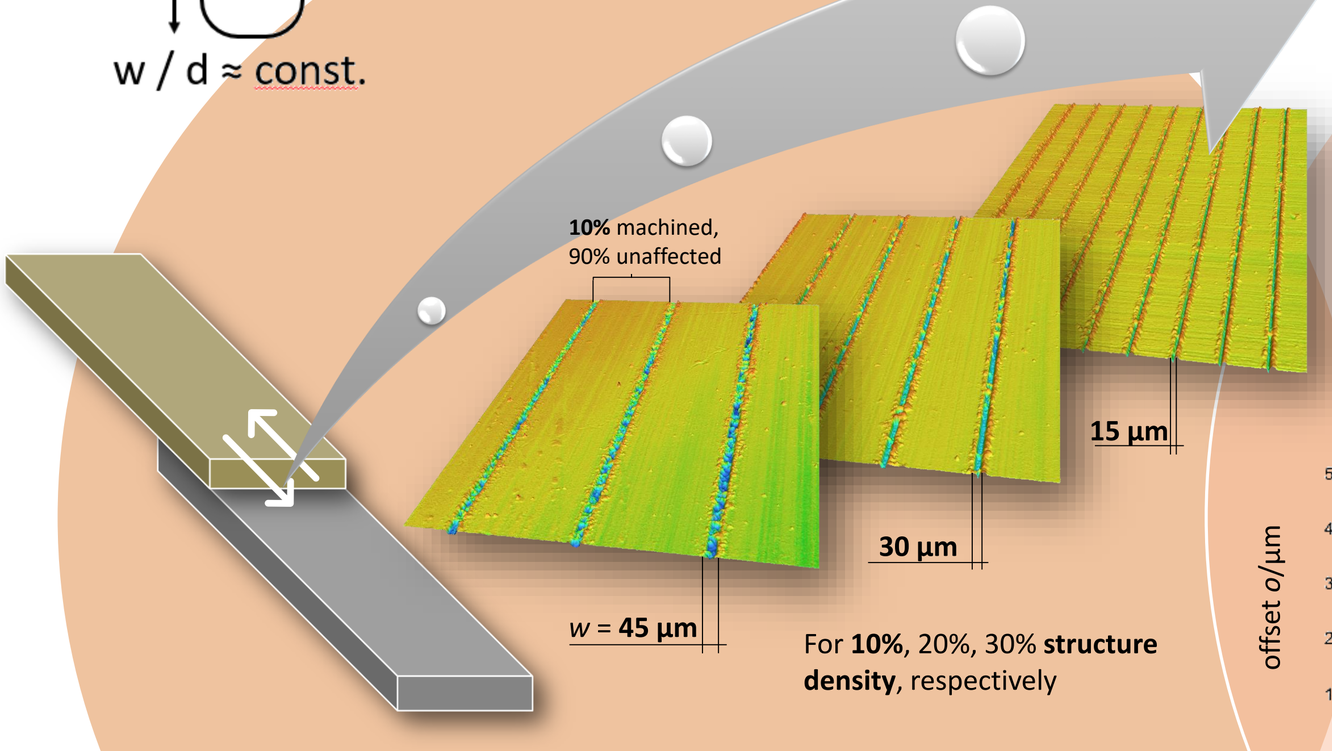
INTRODUCTION & AIM

- Combining **polymers and metals** in lightweight construction depends on **mechanical interlocking**, enhanced by surface structuring
- **Laser-Beam Machining** enables complex adhesion-promoting profiles
- Suitability of **Fractal Dimension** as scale-independent criterion for **adhesion strength prognosis** reported previously
- Research Question: How does **scaling** of laser-machined groove structures affect 1. The fractal dimension criterion 2. The adhesion strengh in lap shear tests?

EXPERIMENTAL – Laser-Beam Machining



Scaling of groove structures with **similar aspect ratios**



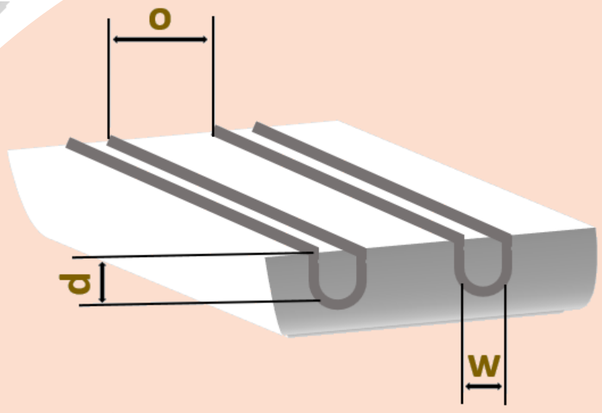
For **10%**, 20%, 30% **structure density**, respectively

Hot joining of aluminum 6082 to polyamide 6 (30% glass fiber) for **lap shear tests**

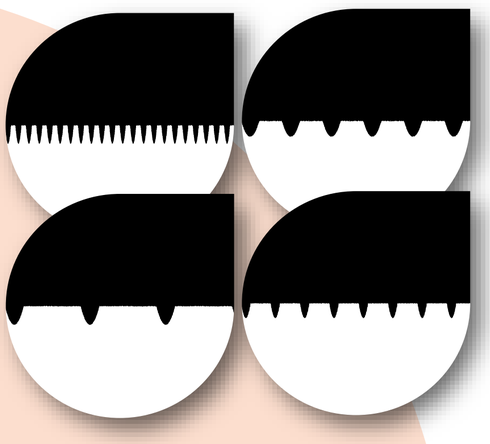
MODELING – Monte Carlo Method

Variations of groove dimensions

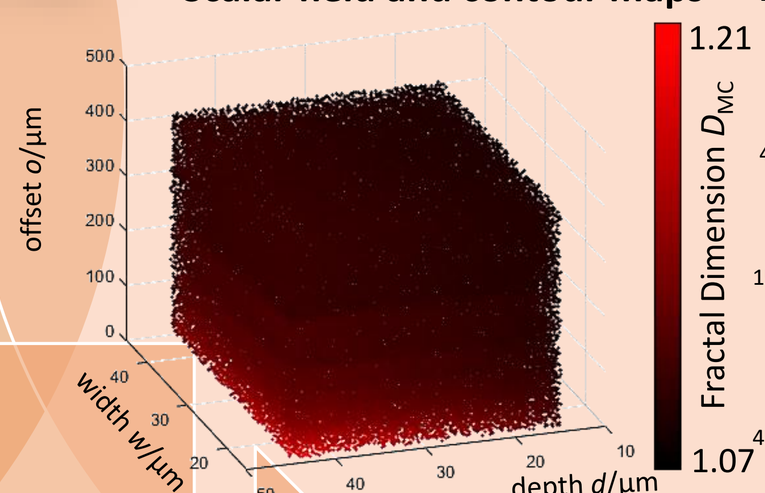
o … offset, *d* … depth, *w* … width

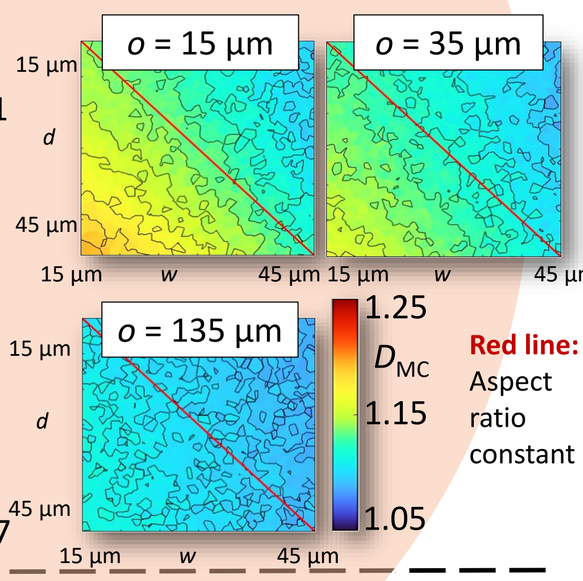


Virtual cross-sections

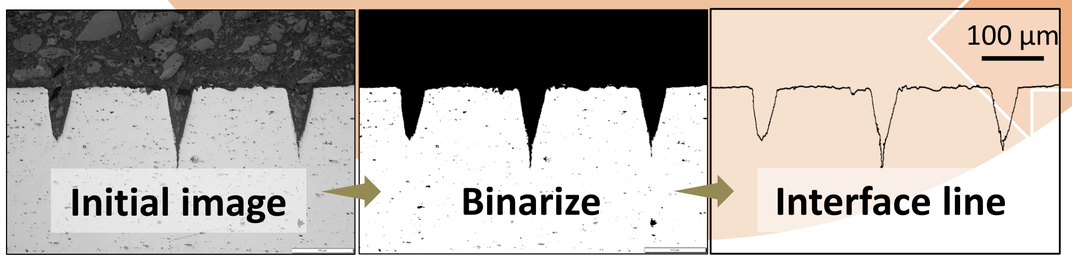


Scalar field and contour maps

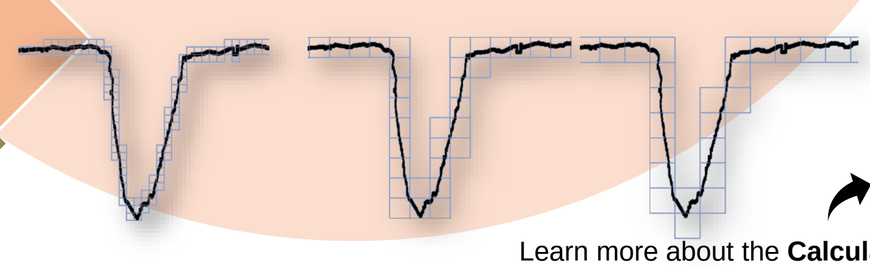




Red line: Aspect ratio constant

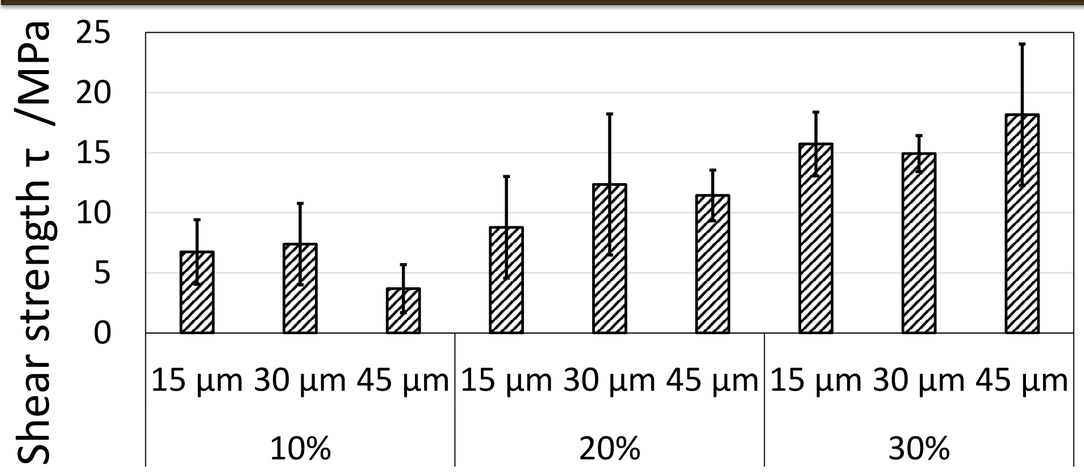


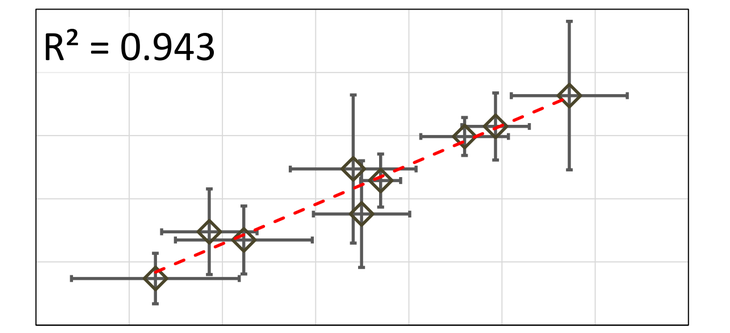
Box-Counting Algorithm



Learn more about the **Calculation Method**

CONCLUSIONS





- **Fractal dimension** used as **quantitative correlation** criterion for strength prognosis
- **Scale independency indicated** for fractal dimension (real and modeled) and lap shear strength
- Validation of **surface model** for design and prognosis $D_{LBM} \approx D_{MC}$

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