

# SINGLE FIBRE PULL-OUT TEST

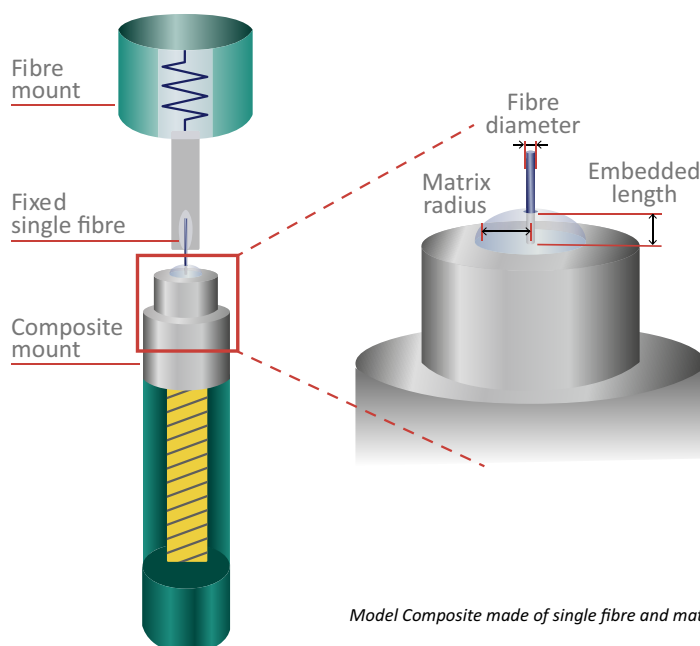
## Characterization of fibre-matrix adhesion

### Fields of work

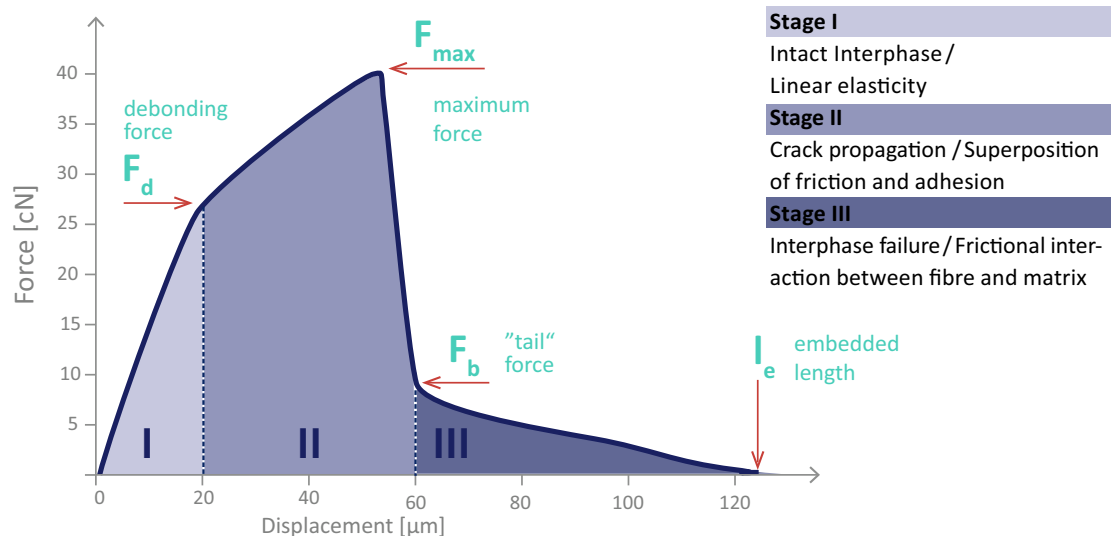
The single fibre pull-out (SFPO) test enables an insight into the interphase properties that arise during consolidation or curing processes of fibre reinforced composites (FRC).

The morphology and the resulting interphase properties are specific for each fibre-matrix combination and depend on: applied fibre sizings / coatings, surface roughness, matrix properties, time- and temperature regimes, etc.

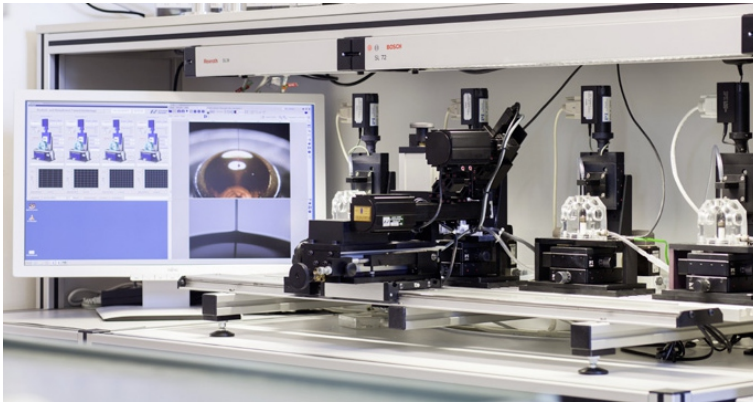
### Experimental setup



### Characteristics of the force-displacement curve

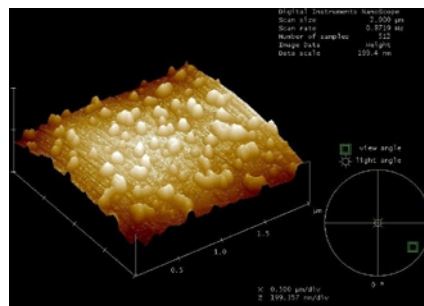
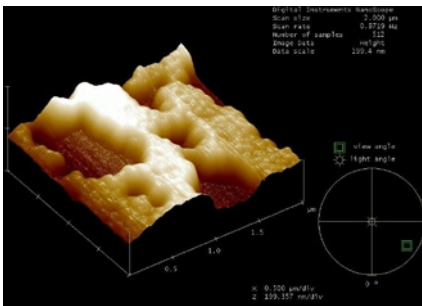


- Determining SFPO parameters  $F_d$ ,  $F_{max}$ ,  $F_b$  and  $l_e$
- Calculating interfacial parameters: the apparent shear strength, the local shear stress or interfacial toughness by the stress-based or energy-based approach [1,2,3].



### Fields of work

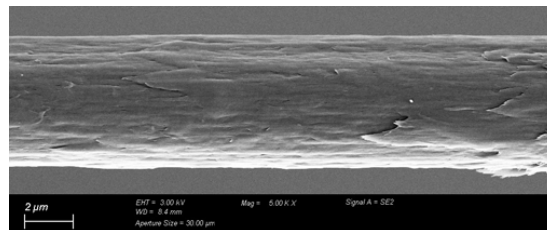
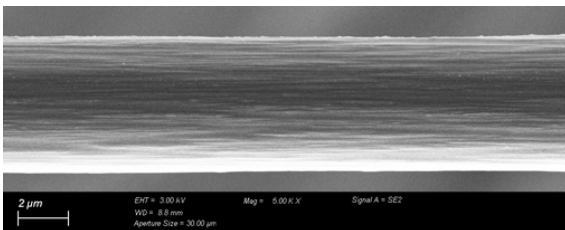
- Micromechanical tests at quasi-static or dynamic loading
- Micro fatigue tests
- Tailored interphases
- Fibre / concrete adhesion



AFM images of sized fibre surfaces

### Single fibre pull-out characteristics

- SFPO is a micromechanical testing method
- Micromechanical investigation allows a detailed look on fibre-matrix interaction by excluding external influences, such as fibre content, orientation and distribution, porosity or further influences during composite processing
- Comprehensive studies are possible using less amounts of fibres and polymer facilitating the investigation of new materials and / or material combinations
- SFPO test enables the investigation of the fractured fibre surfaces after pull-out



Carbon fibre surface after single fibre pull-out

### References

1. Zhandarov, S.; Mäder, E. Characterization of fibre / matrix interface strength: applicability of different tests, approaches and parameters. *Compos. Sci. Technol.* 2005, 65, 149–160.
2. Zhandarov, S.; Mäder, E. Determining the interfacial toughness from force-displacement curves in the pull-out and microbond tests using the alternative method. *Int. J. Adhes. Adhes.* 2016, 65, 11–18
3. Zhandarov, S.; Mäder, E. An alternative method of determining the local interfacial shear strength from force-displacement curves in the pull-out and microbond tests. *Int. J. Adhes. Adhes.* 2014, 55, 37–42.
4. Scheffler, C.; Zhandarov, S.; Jenschke, W.; Mäder, E. Poly(vinyl alcohol) fibre reinforced concrete: investigation of strain rate dependent interphase behavior with single fibre pullout test under quasi-static and high rate loading. *Journal of Adhesion Science and Technology* 27 (2013) 385–402

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