

Particle-bed 3D printing by Selective Cement Activation (SCA) – Sustainability, process enhancement and material models

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Project aims of 2nd funding period

Environmental sustainability

- Reduction of carbon footprint in SCA by lowering the cement clinker content and using recycled material
- Achieving higher durability by e.g. after printing treatment

Process enhancement

- w/c-ratio gradation to enhance dimensional accuracy with high strength
- Robot assisted multi material printing and reinforcement integration

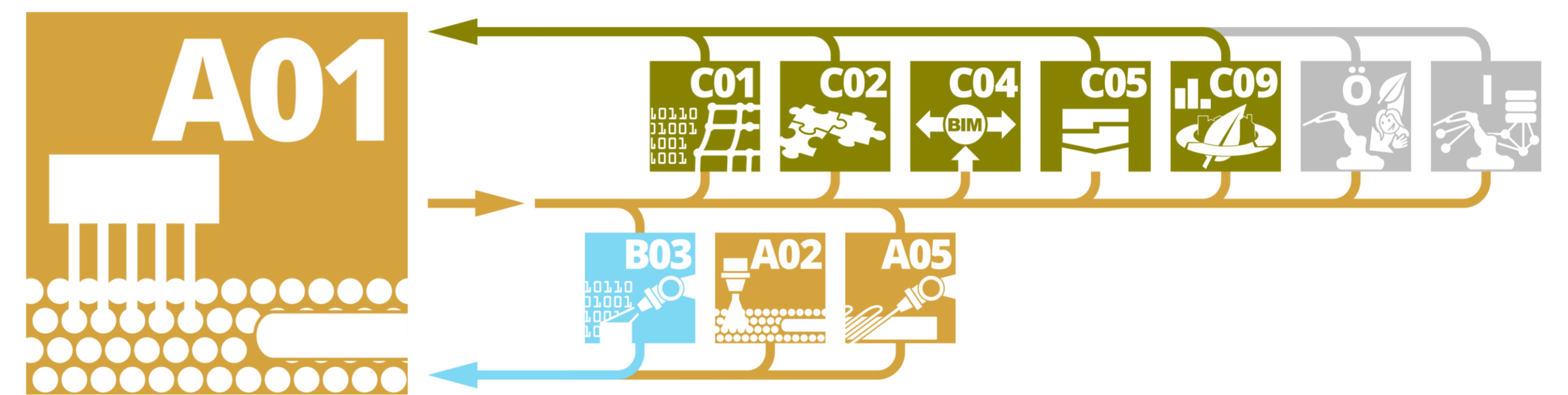
Material models

- Spreadability and compaction of the particle-bed
- Liquid intrusion into the particle-bed
- Material models for early age strength and limit load

Large-scale 3D printing

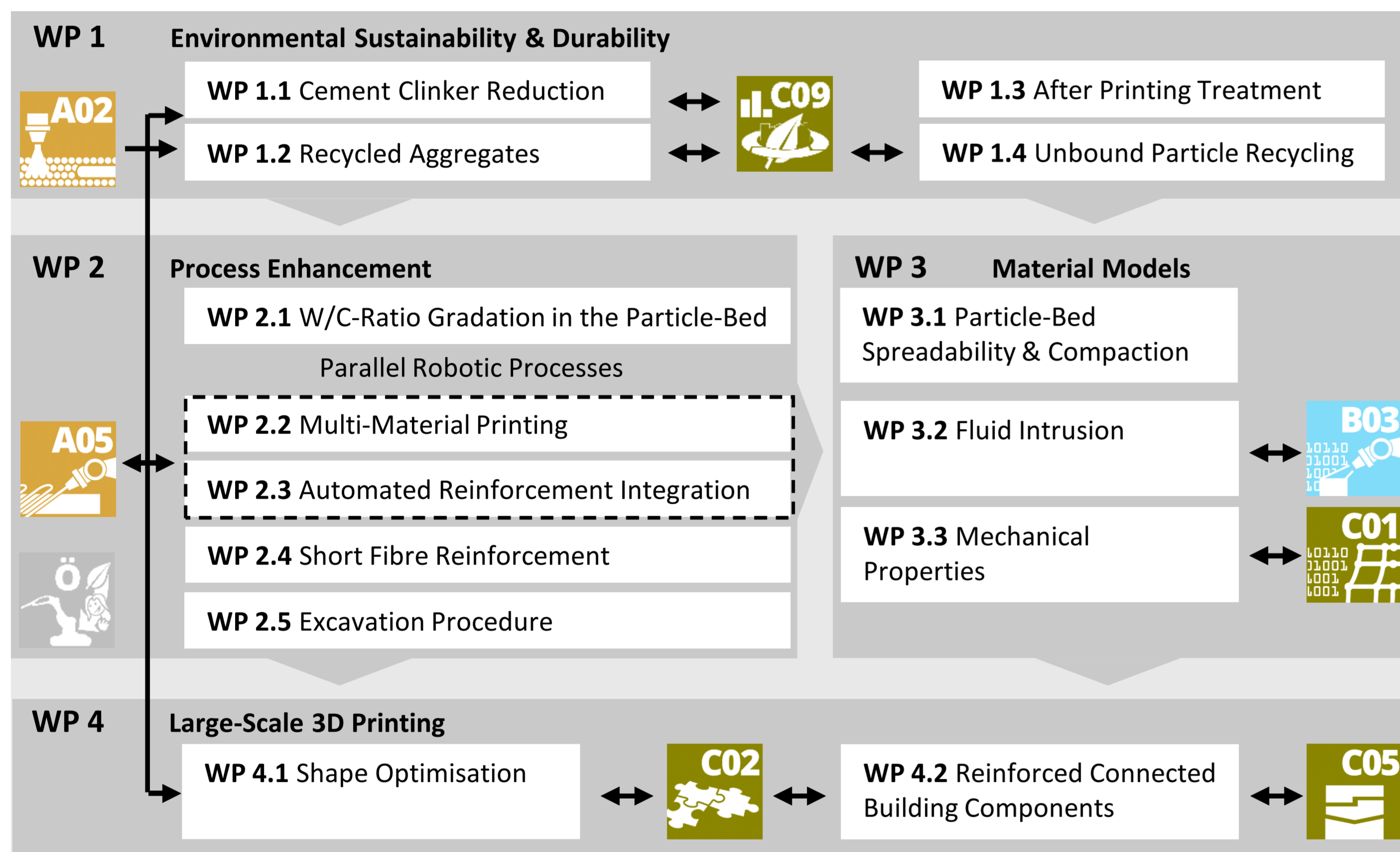
- Shape optimised components, segmentation and connections

Key collaborations in 2nd funding period



- B03: Development of a physical model for the numerical simulation of liquid intrusion into the particle-bed
- C01: Development of a material model for numerical simulations taking into account the material inhomogeneity caused by the printing process
- C02: Investigation of shape optimised building components
- C05: Investigation of segmentation and connection strategies

Work programme



Environmental sustainability

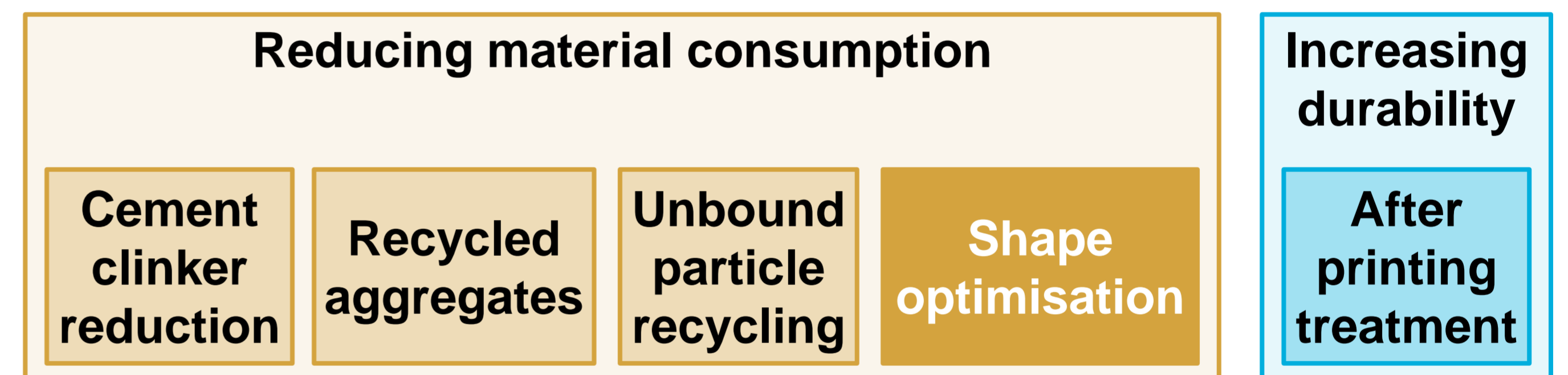


Fig. 9: Fresh particle mixture for SCA.

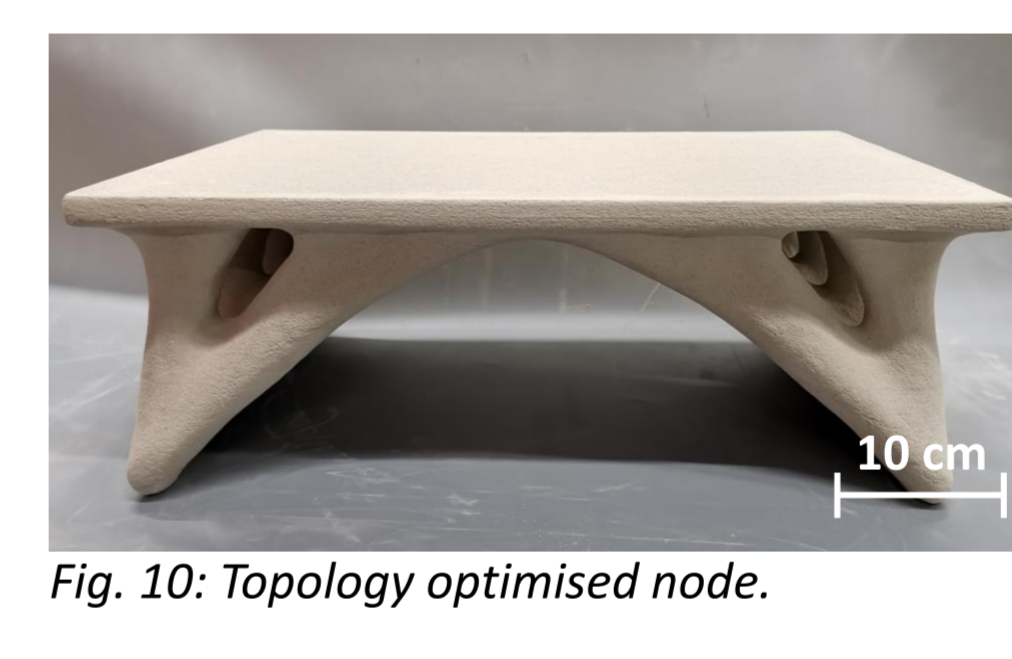


Fig. 10: Topology optimised node.

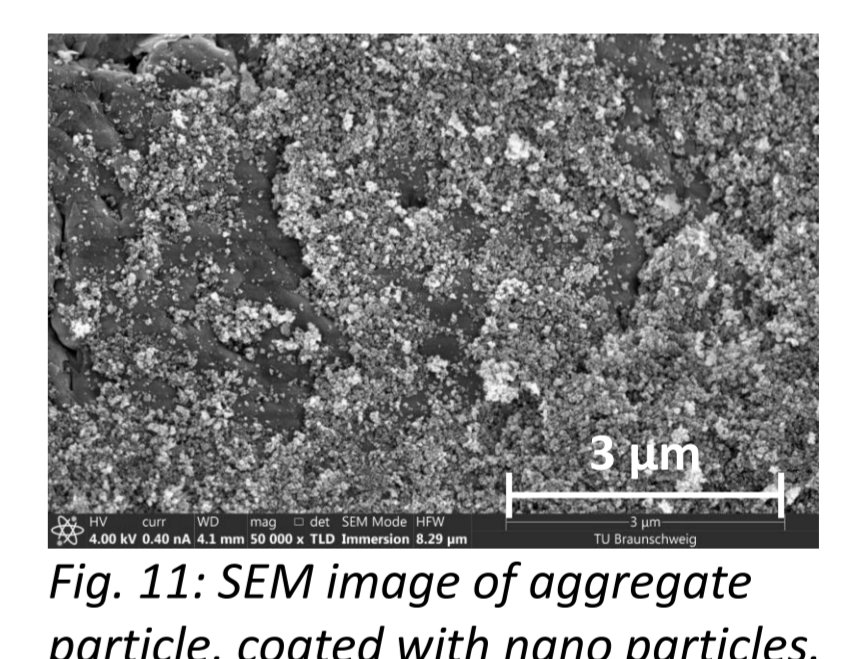


Fig. 11: SEM image of aggregate particle, coated with nano particles.

Material models

Mechanical properties

- Correlation of Youngs modulus and μ CT grey values
- Measurement of early age strength for various process parameters

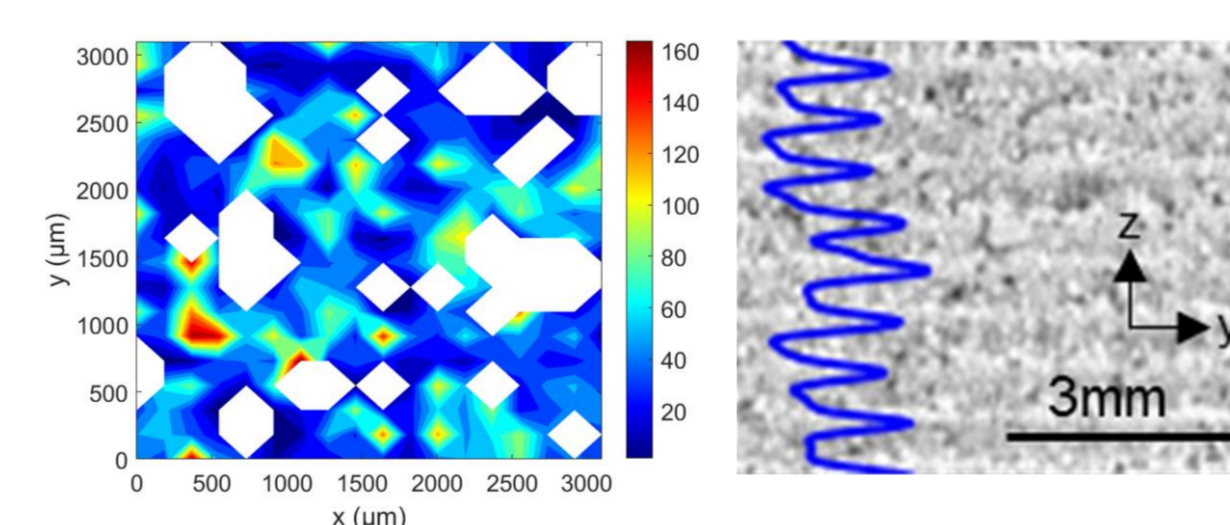


Fig. 14: Mapped Youngs modulus measured by micro indentation (left) and μ CT grey value distribution over multiple layers (right).

Particle-bed spreadability & compaction

- Characterisation of e.g., flowability ϕ , angle of repose and correlation with in situ spreadability

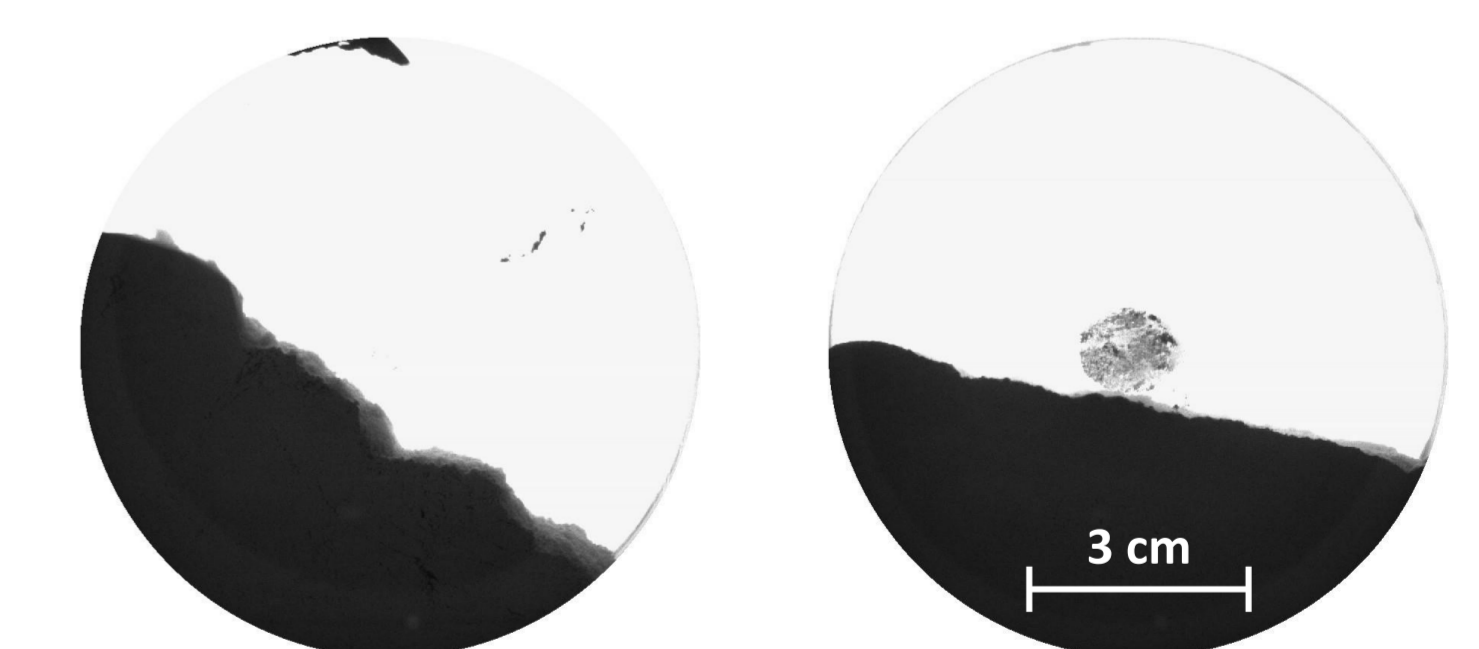


Fig. 15: Dynamic angle of repose of a bad (left) and good (right) flowing bulk material.

Process enhancement

W/C-ratio gradation

- Evaluation of bond strength with inter layer reinforcement
- Evaluation of dimensional accuracy

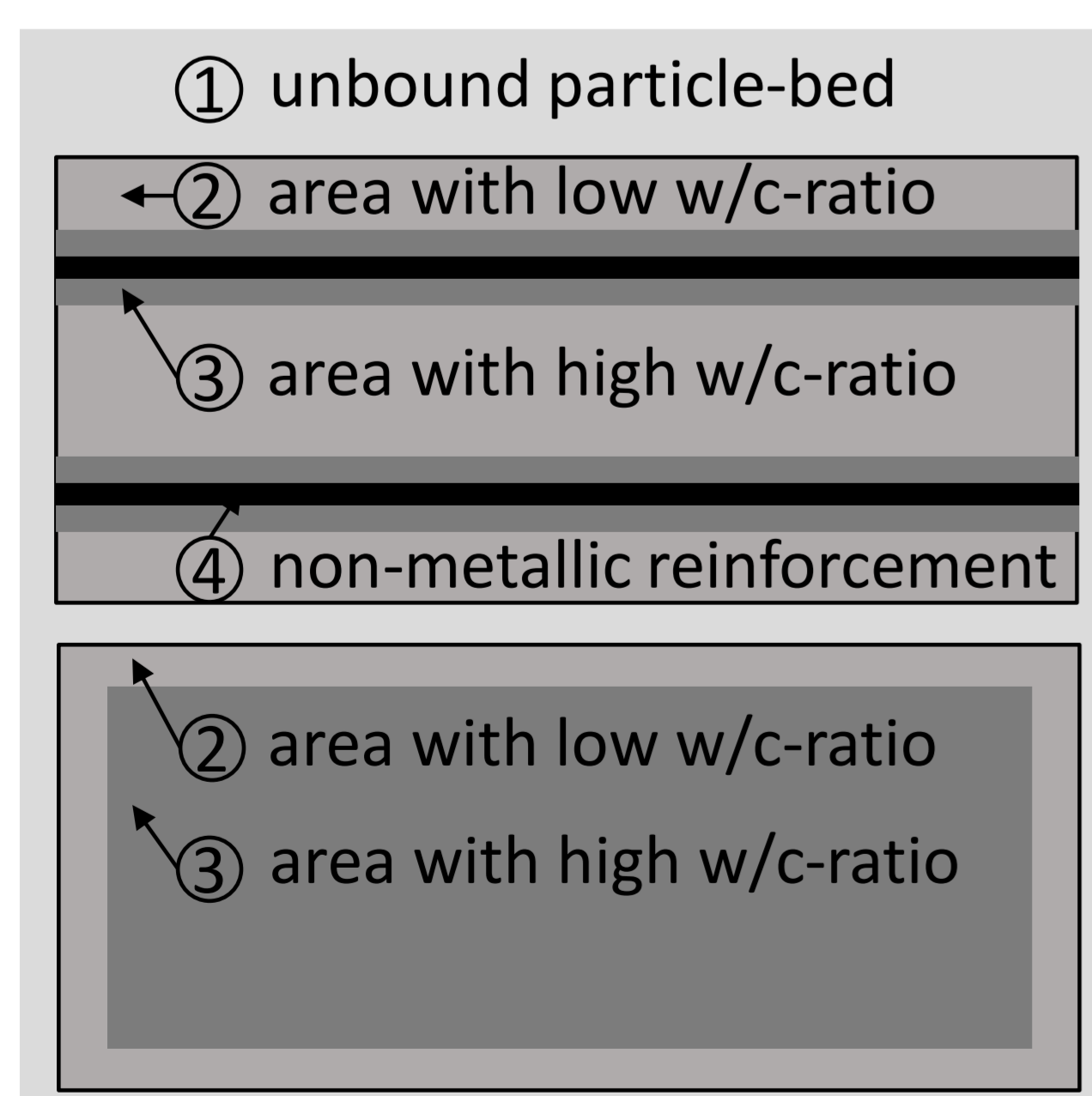


Fig. 12: Illustration of w/c-ratio gradation.

Process parallel collaborating robots

- Fully automated inter layer reinforcement integration and multi material printing

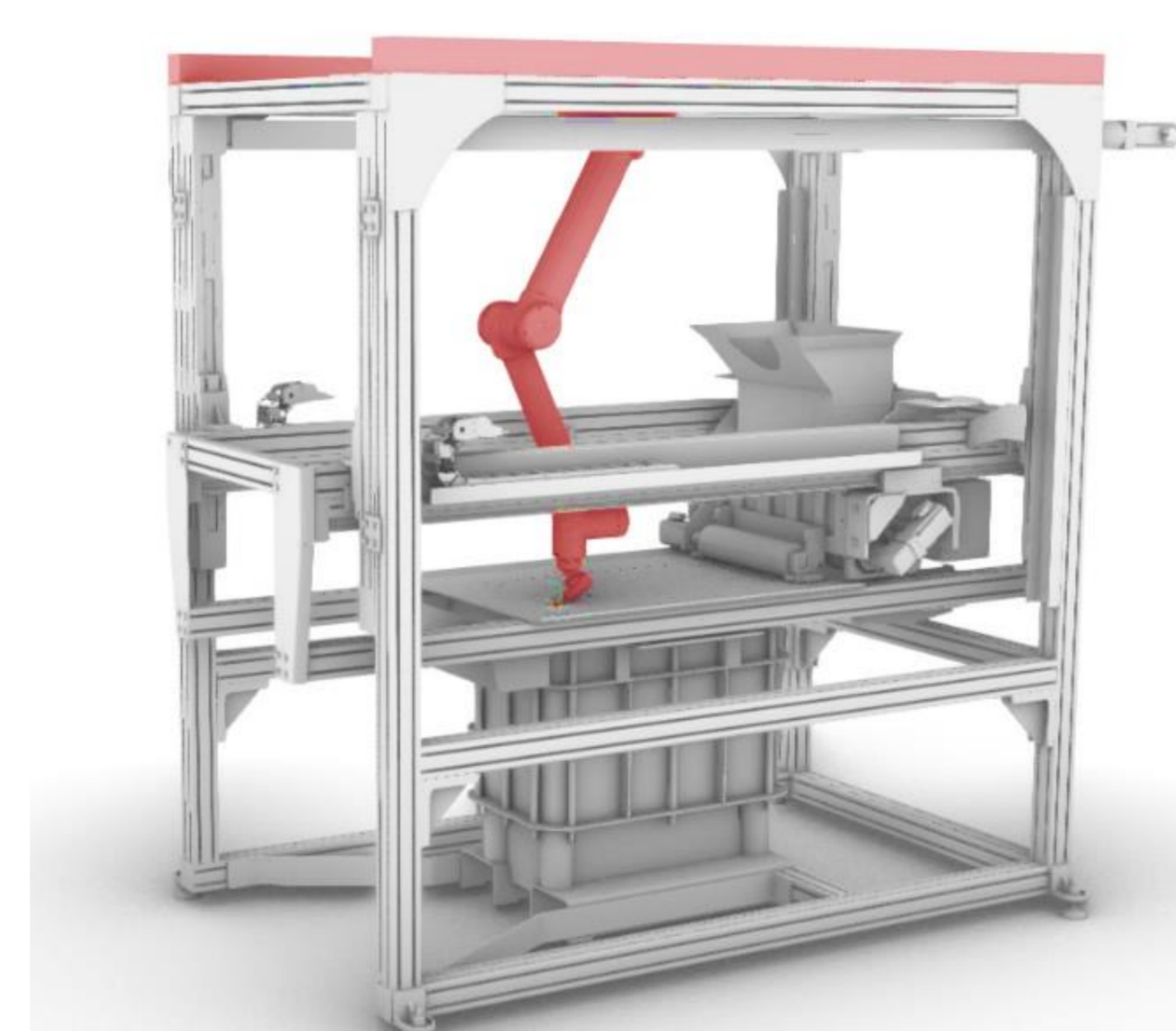


Fig. 13: Illustration of a collaborative robot in the SCA lab printer

Outlook 3rd funding period

- Providing a basis for implementation in practice and standardisation
- Material models as basis for design rules for mechanical properties and durability
- Rules for reconditioning of the unbound particle bed
- Full automation and handling of process disturbances