Heavy User Experience

Printing Innovative and Newly Developed Nanocomposite Materials for High Performance Additive Manufacturing with **Sharebot Snowwhite² Nitro LPBF Printer**

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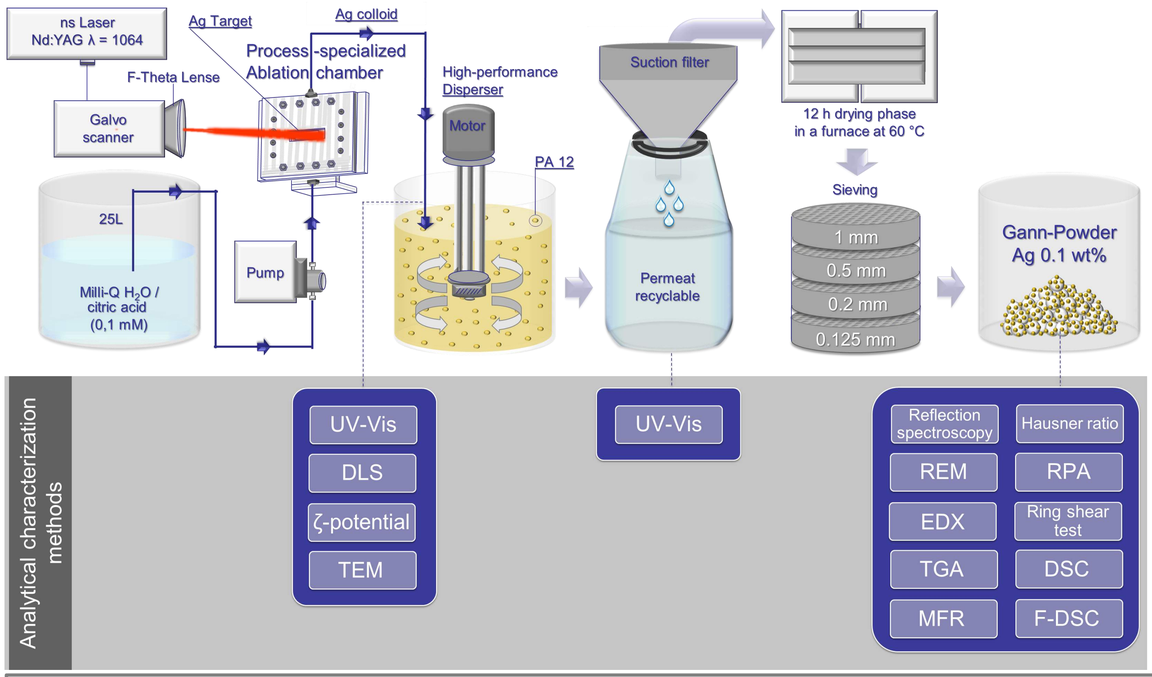
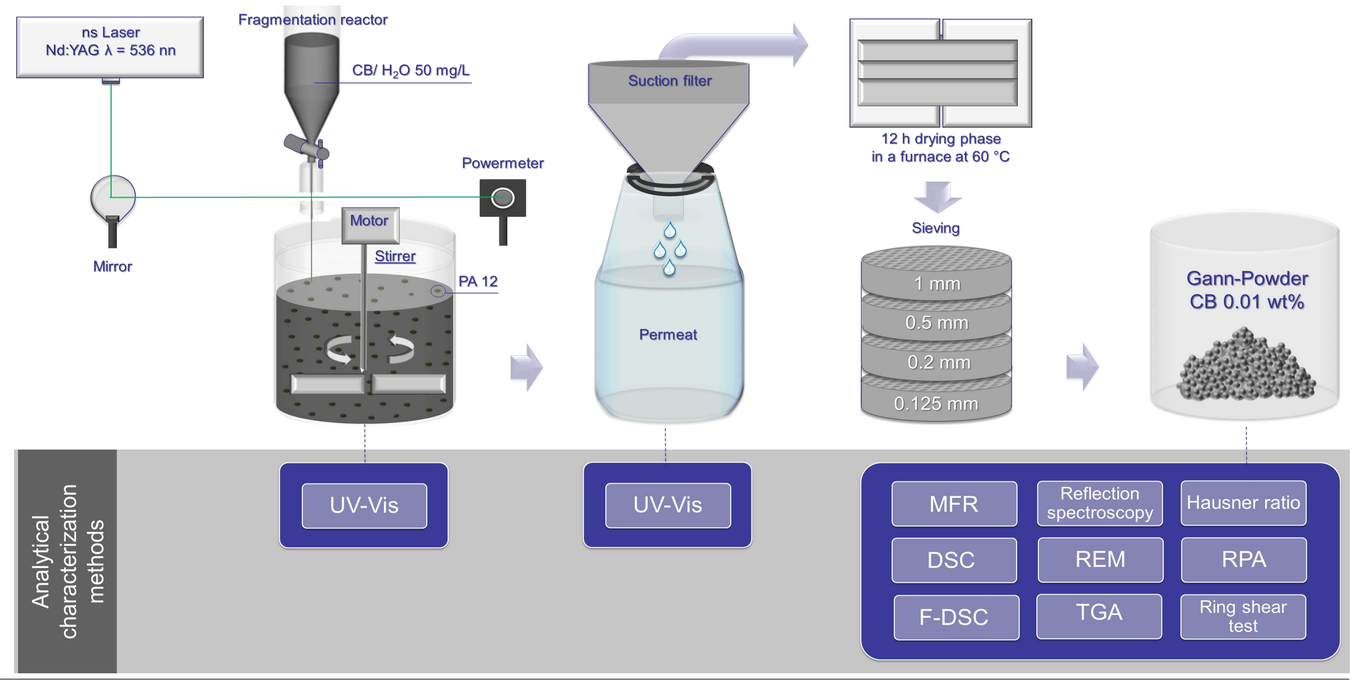
SPP 2122 Priority Program: "New Materials for Additive Manufacturing"

- **Synthesis and matrix formulation:** How shall process parameters and materials properties be adapted to the laser-based additive manufacturing process via matrix modification (e.g., alloying, doping, compounding) of powders?
- **Particle surface formulation and additivation:** How shall target properties like flowability, wetting, porosity or (heterogeneous) nucleation be adapted to the laser-based additive manufacturing process via surface modification of powders?
- **In-situ measurements and process dynamics:** How may calorimetry, high-speed videography, pyrometry and online spectroscopy as well as modelling contribute to understand the melting and recrystallisation dynamics as well as the lateral distribution of the thermal process window? **[1]**

Ag Ablation & Semicontinuous Supporting Process ➔ Gann-Powder-Ag



Carbon Black Fragmentation and supporting Process ➔ Gann-Powder-CB



Inter-Laboratory Study (Round Robin Test)

- Inter-Laboratory Study Design all Along the Process Chain, including Research Data Management of nanoparticle additivation effects on LPBF of metals and polymers the test methods to measure the NP-additivated metal and polymer powder feedstock properties and resulting part properties.
- 9 participants for LPBF of metal powders
- 10 participants for LPBF of polymer powders

Quantify the inter-laboratory variability in: densification, geometric tolerance,
microstructure and mechanical properties as well as virgin & used powder properties

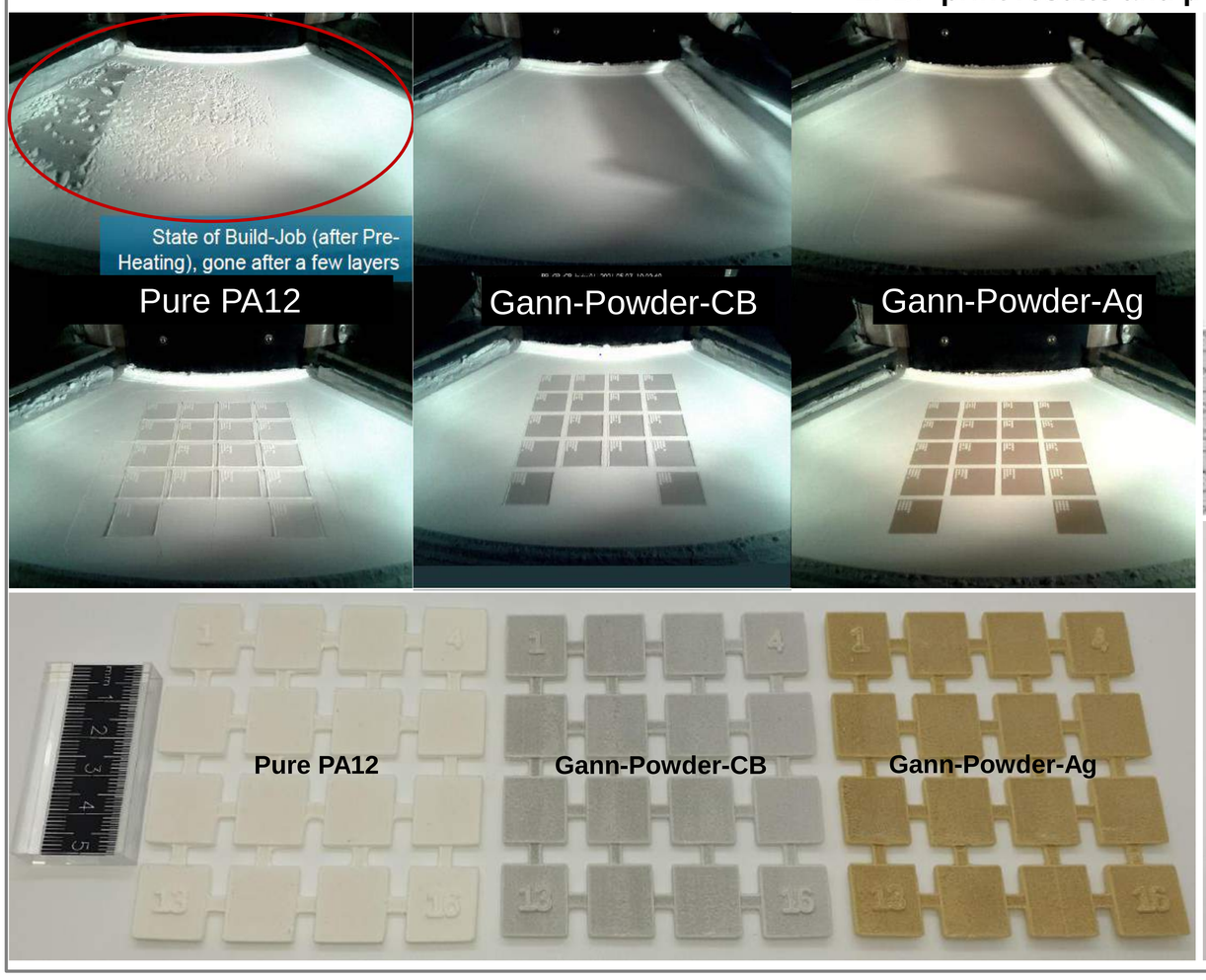
- A research data management (RDM) plan is designed to extract scientific results from the vast amount of material, process, and part data. Peer-reviewed publication, seed data for AM materials database ›› **Digital Twin**
- The RDM focuses not only on the repeatability and reproducibility of a metric but also on the FAIR principle to include findable, accessible, interoperable, and reusable data/meta-data in additive manufacturing.
- The proposed ILS design gives access to principal component analysis (PCA) to compute the correlations between the material–process–microstructure–part properties.**[2]**

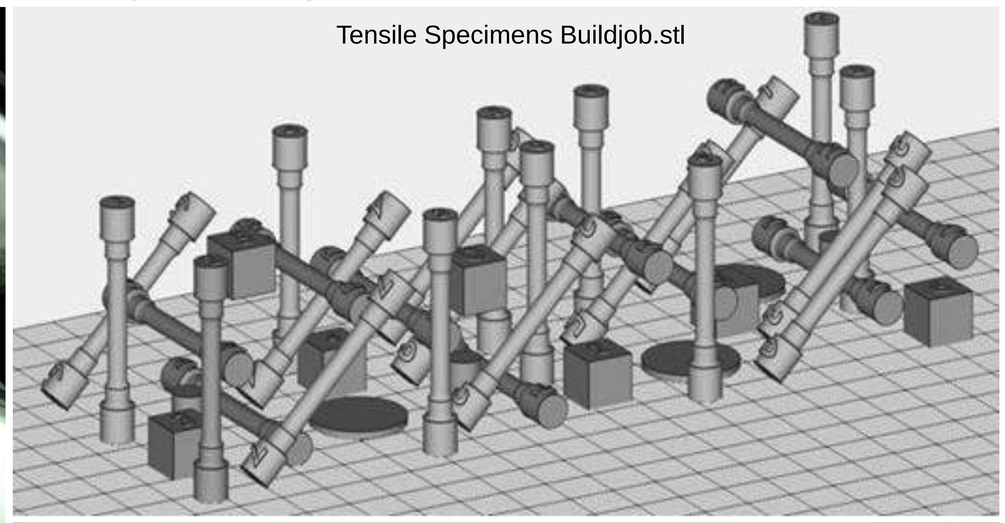
Steps of Polymer Inter-Laboratory Study (Round Robin Test)

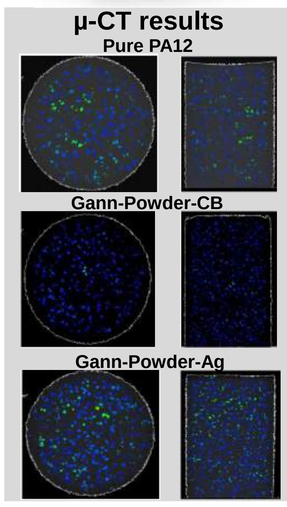
Pre-test ›› Pilot-run ›› Full-run

Nanocomposite LPBF Polymer Gann-Powders Production for ILS ›› Total of 250 kg

LPBF print results and µ-CT analysis of the specimens







Summary of print results:

- ✓ Manipulation of the melting and reconsolidation behavior of nanocomposite LPBF Gann-Powders
- ✓ Improved behavior of the powder bed surface after preheating prevents warping and produces better print results
- ✓ Prevention of fail prints
- ✓ Better mechanical properties of the printed parts
- ✓ Better solidification behavior with less and more spherical pore formation
- ✓ More accurate print parts geometry

Heavy user experience witch Snowwhite² LPBF 3D Printer

- ✓ Quick and easy procurement with fast delivery
- ✓ Online training
- ✓ Easy handling and maintenance of the printer
- ✓ Easy print monitoring with the Build chamber WiFi camera
- ✓ Open system with many changeable print parameters
- ✓ Precise and repeatable printing results
- ✓ A wide range of LPBF materials and colors can be printed with the CO_2 laser and an inert gas pressure chamber

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References

[1.] Gökce, B.; Barcikowski, S.; Behrens, P.; Fritsching, U.; Kelbassa, I.; Poprawe, R.; Esen, C.; Ostendorf, A.; Voit, B.: Prozessadaptierte Materialien für die Photonik. In: Photonik 1 (2015), S. 24-28 Photonik

[2.] Kusoglu, I.M.; Huber, F.; Doñate-Buendía, C.; Rosa Ziefuss, A.; Gökce, B.; T. Sehrt, J.; Kwade, A.; Schmidt, M.; Barcikowski, S. Nanoparticle Additivation Effects on Laser Powder Bed Fusion of Metals and Polymers—A Theoretical Concept for an Inter-Laboratory Study Design All Along the Process Chain, Including Research Data Management. Materials 2021, 14, 4892. https://doi.org/10.3390/ma14174892