Fraunhofer ICT

Additive Manufacturing

Material and process development

Additive Manufacturing (AM) has great potential for novel industrial applications in the context of Industry 4.0, combining freedom of design (e.g. bionic structures), flexibility of production (small series) and product individualization. However, for the successful industrial implementation of AM technologies, several challenges still need to be overcome: limited material options, difficulty of combining different materials, strong dependency of the final properties on the printing strategy and parameters, and long manufacturing times. At Fraunhofer ICT, we are working to solve these problems by developing new materials and processing technologies for thermoplastic-based AM.

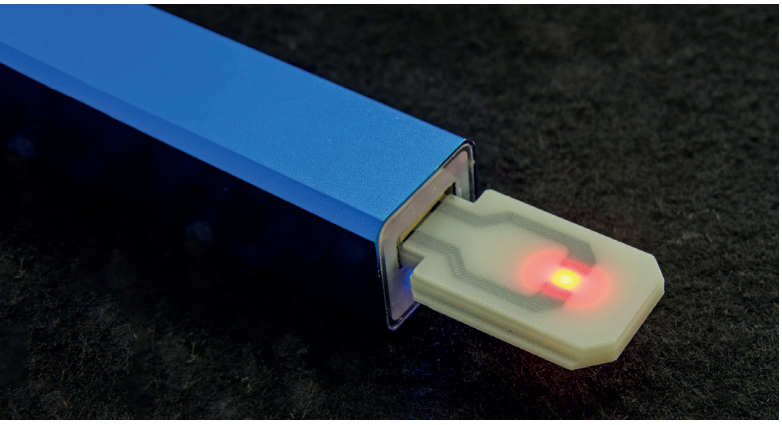
AM machine at Fraunhofer ICT.

Fields of research at Fraunhofer ICT

- Material optimization for AM (pellets and filaments)
- Bio-based polymers
- Short glass-/carbon-fiber-reinforced high-performance thermoplastics
- AM of continuous fiber-reinforced structures
- Tailored functional nanocomposites (e.g. for thermal, electrical, antibacterial properties)
- Recycling material

In cooperation with

Karlsruher Forschungsfabrik®



Demonstrator "light stick" – USB stick with integrated LED connected with electrically conductive nanocomposites (2-component printing).

Formulation development and material functionalization

Experts select thermoplastic matrices and suitable (functional) fillers according to the application. Generally, any commercially available plastic can be used as a matrix material for extrusion-based AM. Biobased and biodegradable polymers (e.g. PLA, PHB) are produced, modified and optimized for AM processes. High-performance thermoplastics (e.g. PEEK, PPS, PPSU) reinforced with glass or carbon short fibers are suitable for demanding applications where traditional engineering thermoplastics cannot be applied. Metals or carbon-based materials can be used as fillers, for example in electrically conductive composites. Processability, and especially the melt viscosity of the composite, also plays an important role.

Besides traditional particles for functionalization, nanomaterials can also be used. Carbon nanotubes (CNTs) enable electrically conductive composites with considerably lower filler concentrations than can be achieved with metal fibers or conductive carbon black. As a result, the viscosity of the melt and the mechanical properties of the composite compared to the matrix material are less strongly affected.

Process development

The target properties of printed parts depend on the complete production chain, from the compounding of the polymers to the filament production to the printing of the parts. Our specialists monitor the entire production chain and optimize technological and economic aspects of both the material composition and the production processes.

By combining conventional short fiber-reinforced or unreinforced polymers with continuous glass or carbon fiber reinforcements, the mechanical properties of additively manufactured parts can be significantly improved. Using our state-of-the-art filament manufacturing and additive manufacturing equipment, we can tailor the material and the process to the requirements of our customers.

Equipment available at Fraunhofer ICT

Technical equipment available for formulation development ranges from various small-scale mixers, kneaders and extruders through to pilot plant compounding lines in which the composite is supplied as granules. A filament extrusion line for the production of thermoplastic filaments with diameters of 1.75 mm and 2.85 mm is also available.

The equipment available for process development in additive manufacturing includes the extrusion-based additive manufacturing processes Arburg plastic freeforming (APF) with a two-component freeformer 200-3X and one- and two-componenten fused filament fabrication (FFF) machines for processing unreinforced, short fiber-reinforced and continuous fiber-reinforced materials.

In addition, accompanying technologies such as plasma processes for the pre-treatment of printable substrates, or microwave processes for the post-treatment of additively manufactured components, as well as the accompanying characterization of materials and components, are provided by the test laboratory.

Our offer

We offer our customers services ranging from basic investigations and feasibility studies to process engineering implementation.

- Feasibility studies
- Benchmark testing (APF, FFF, injection molding)
- Formulation development (filaments, granules)
- Determination of suitable processing parameters
- Consultancy in process and component design
- Characterization of materials and components

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