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Application of new composites for Fused Deposition Modeling (FDM) technology in wood industry

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Additive Manufacturing (AM) Technologies

Additive Manufacturing represents technologies that fabricate objects layer-by-layer of material, directly by using the virtual CAD models. Any material can be used, but nowadays only limited range of materials are applied in practice. **Rapid prototyping (RP)** was initially used as a term, substituted by AM as more standard term, several years ago. Also, commonly used term is **3D printing**, referring to any AM technology that produces three-dimensional objects

Fused deposition modeling (FDM) is one of the technologies used for 3D printing. Material is in the form of a plastic filament or metal wire that is unwound from a coil and heated within the device and exit the nozzle as molten material to fabricate layered final structure of custom shape.

- Modeling of the final object shape
- Software preparation for 3D printing -.stl file
- 3D printing process
- Post-processing

Basic material classes in FDM

- Polylactide (PLA): low cost, biodegradable thermoplastic with wide applications
- Acrylonitrile Butadiene Styrene (ABS): amorphous production-grade thermoplastic
- Nylon: high fatigue resistance, strong chemical resistance
- Polyphenylsulfone (PPSF/PPSU): heat and chemical resistant thermoplastic

Advantages of FDM technology

Clean, simple-to-use and office-friendly

Minimum waste

No post-processing

Affordable, low cost 3D printers

Possibility to use custom made composite materials

Drawback of FDM technology

Limited accuracy of final 3D printed surface

Unpredictable shrinkage of the material

The cost of 3D printers has decreased dramatically from $20,000 now down to less than $1,000

Keywords: Additive Manufacturing; Composite materials; 3D printing

New composites for Fused Deposition Modeling (FDM)

Pulsed laser deposition (PLD) is a thin film deposition (specifically a physical vapor deposition, PVD) technique where a high power pulsed laser beam is focused inside a vacuum chamber to strike a target of the material that is to be deposited. This material is vaporized from the target (in a plasma plume) which deposits it as a thin film on a substrate material facing the target. This process can occur in ultra high vacuum or in the presence of a background gas.

PLD presents some advantages over other methods for the fabrication of metal nanoparticles and the manipulation of their properties, since it is possible to change various parameters such as: laser wavelength, pulse duration, ambient gas pressure, energy per pulse, target-substrate distance, etc., to control the size and distribution of nanoparticles. In spite of this, only a few sets of deposition conditions have been investigated for depositing silver (Ag) nanoparticles, and there is still controversy on which are the best conditions for their efficient synthesis.

Figure 1. Desktop filament extruder and three different materials, Center for Information Technology (CIT), Faculty of Engineering, Kragujevac

Some novel materials include:

- Graphene or carbon nanotubes (CNT) incorporated in the polymer matrix
- Metal - polymer composites
- Bio-Organic composites: wood waste particles or fibers mixed into the polymer matrix
- Biodegradable materials for medical devices and scaffolds

Quality of fabricated elements is influenced by the selection of materials, temperature regimes that can be controlled by the device, printing speed, preselected shapes and other. Operator can change several parameters prior to 3D printing.

Results

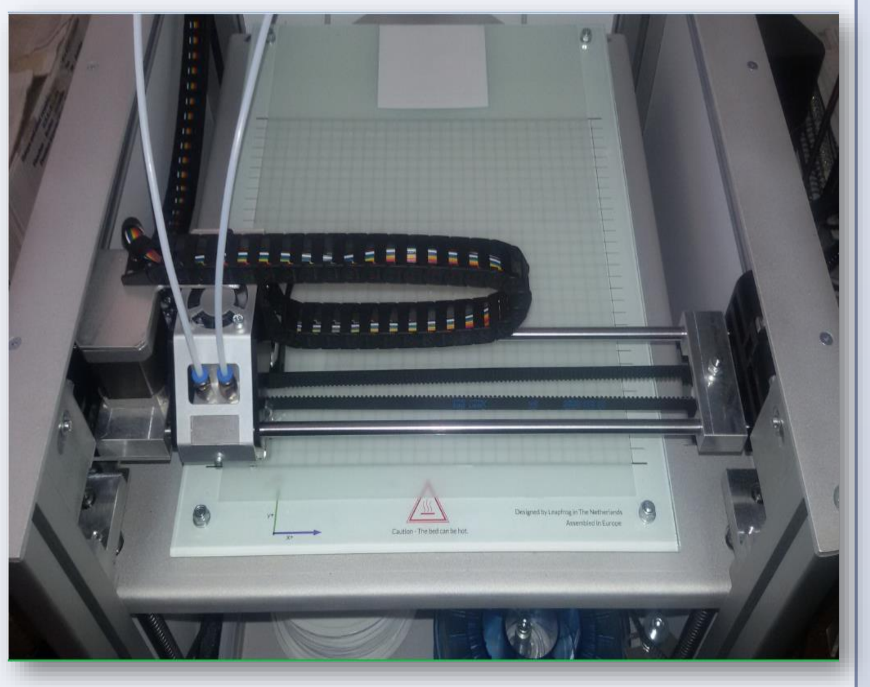

Figure 2. 3D printer with 2 extrusion heads, Center for Information Technology (CIT), Faculty of Engineering, Kragujevac

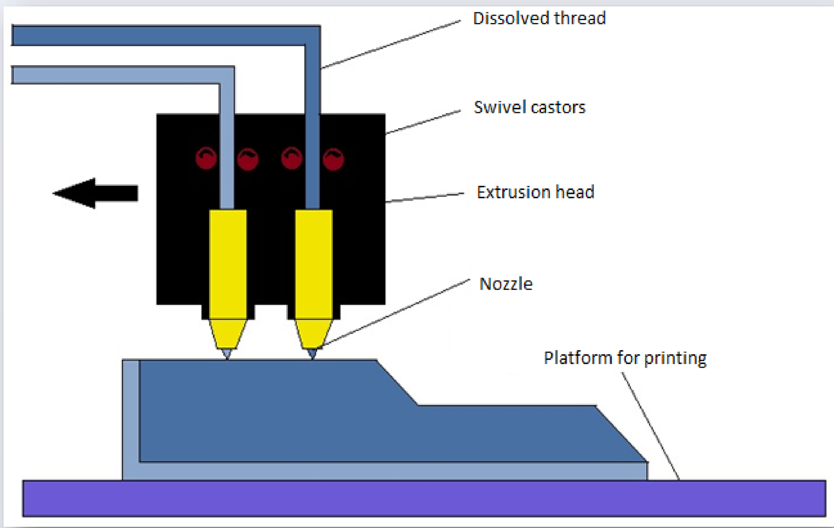

Figure 3. FDM process

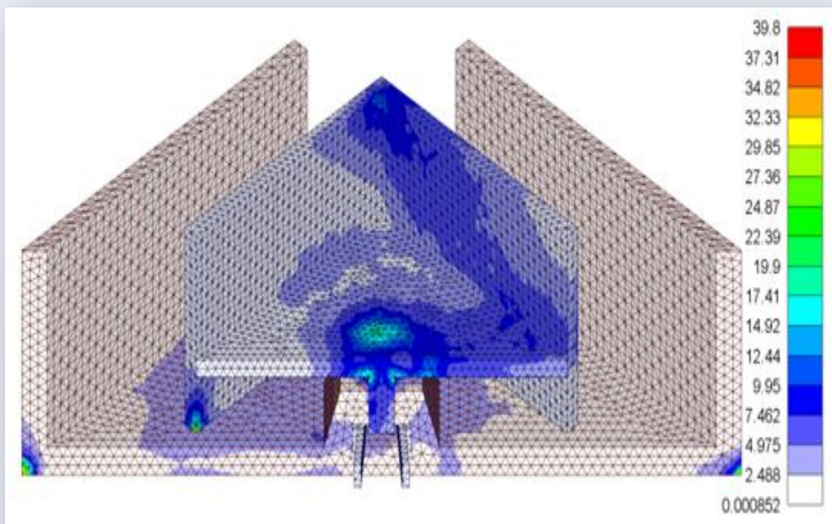

Figure 4. Numerical optimisation of 3D printed elements

Acknowledgement

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Results

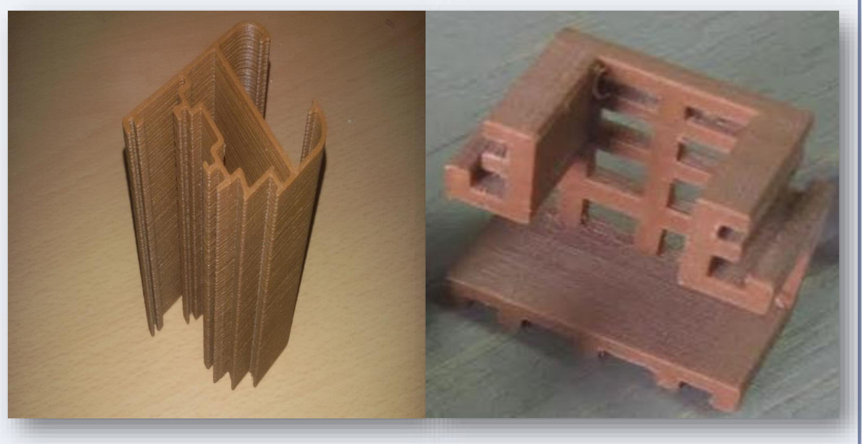

Figure 5. 3D printed elements made of wood-polymer composite (WPC)

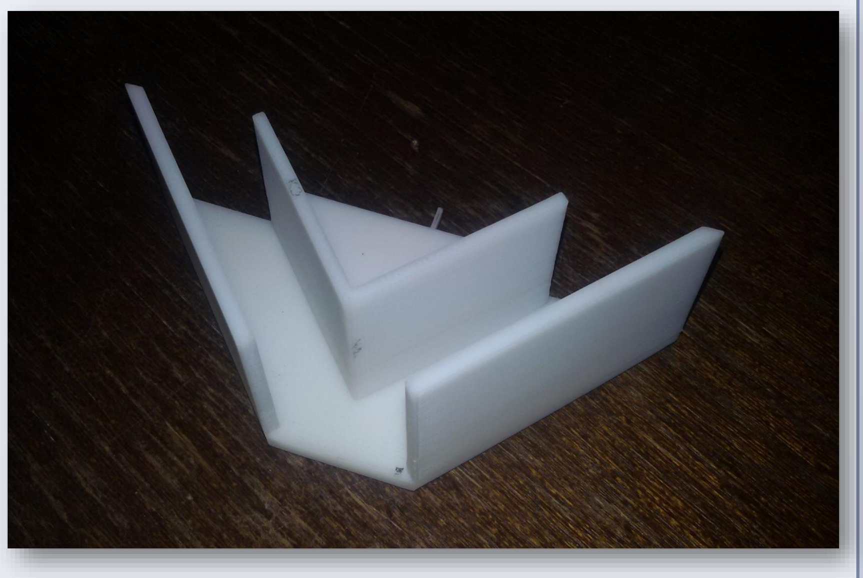

Figure 6. 3D printed tool for wood industry

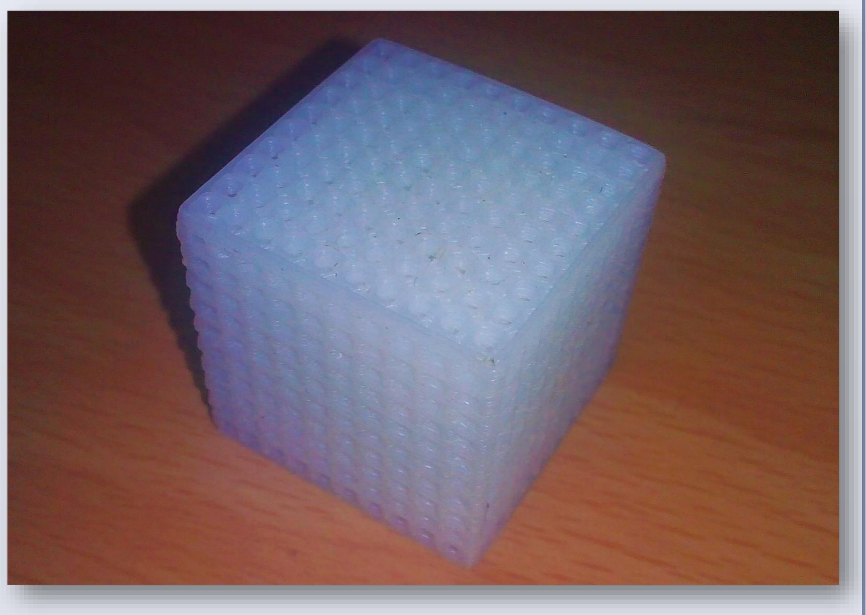

Figure 7. 3D printed scaffold for tissue engineering

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