POLYMER COMPOSITES WITH THE ADDITION OF SELECTED METALLIC FILLERS USED IN ADDITIVE MANUFACTURING TECHNOLOGIES

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AIM

The aim of the work was to obtain new materials and filaments dedicated to 3D printing in three technologies, depending on the device used: *Fused Filament Fabrication* (FFF), *Melted and Extruded Manufacturing* (MEM), *Melt Extrusion Polymers* (MEP). Polylactide (PLA) was used as the matrix due to the desired polymer properties, mainly biodegradability, and the matrix was supplemented by the addition of metallic fillers such as bronze, copper, brass and steel. The mechanical and structural properties of the obtained composites were examined to determine the dependence of the obtained results on the content and type of filler used and the method of making the fittings.

METHODS

As part of the work, a number of determinations were carried out, which allowed to determine the properties of the polymer materials obtained:

- MFR, melt mass flow index was determined using a DYNISCO 4781 Plastometer.
- Rockwell hardness was carried out using a hardness tester, Zwick/Roell, at ambient temperature.
- Charpy impact strength was determined using PSW GEHARD ZORN impact hammer with a strength of 1 J.
- The determination of strength properties during the static tensile test was performed on an INSTRON 5967 testing machine at ambient temperature.
- Hitachi SEM TM3000 scanning electron microscope was used to observe the microstructure of the materials produced.
- Thermogravimetric analysis was performed using TGA Q500 TA Instruments under a nitrogen atmosphere.

CONCLUSIONS

- The proprietary line for obtaining composites based on polymer materials in the form of filament has been developed, which allows to increase the range of polymer materials used in FFF, MEM, MEP technology.
- The mechanical properties of the tested composites were significantly influenced by the technique of their manufacture, as well as the introduction of appropriate powdered metallic fillers such as bronze, copper, brass and steel.
- Molded parts obtained by injection molding had significantly better mechanical properties than fittings obtained with the use of 3D printers.
- The addition of the introduced metallic filler to the polymer matrix resulted in improved fluidity of the material (MFR). Unfortunately, a reduction in Rockwell hardness and Charpy impact strength was observed.
- The regular distribution of filler particles in the PLA polymer matrix was confirmed by the SEM method. According to the results, the particle size in the range of 20-30 μm was determined. The bronze, copper and steel additions used have a spherical shape, while brass has cylindrical particles.
- TGA examination allowed to determine the thermal changes of the material. Unfilled PLA is characterized by high thermal stability and one-stage thermal decomposition, the addition of metallic fillers significantly changes the characteristics of transformations.