FUNCTIONALISING SURFACES OF 3D PRINTED OBJECTS WITH AN INTEGRATED LOW-COST ATMOSPHERIC PRESSURE MICRO PLASMA TORCH

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Polymer 3D printing via the Fused Filament Fabrication (FFF) technology is a now well-known process designed to build three-dimensional objects from computer-aided-design (CAD) models in a layer-by-layer method. First dedicated for prototyping, this technology is now widely spread on the additive manufacturing (AM) and production market. With the decreasing costs of the equipment and materials needed as well as the growing simplicity of use and reliability of the technique, one can now have a 3D printer for the same cost and as user-friendly as a regular desktop inkjet printer. Among the commercially distributed thermoplastics, polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS) are the two most outspread but one can also find acrylonitrile styrene acrylate (ASA), polyethylene terephthalate (PET) polycarbonate (PA) and much more. When assuming that single material 3D printed objects are obtained from growing layers in the (xy) plane stacked along the z axis, they are known to show really good tensile strength in the x and y direction but much less in the z direction due to insufficient interlayer bounding. Bigger problems arise when trying to print a multi-material object. Indeed, the chemical incompatibility of the different printed materials as well as their different thermal expansion coefficients are from the materials properties that can cause a very weak diffusion bonding at the interface. Authors started recently to focus on this problematic and very few studies can be found on the subject. To overcome the problem, we consider here improving the wettability of the printed polymer at the interface layer as it cause the extruded material to better spread over this layer, hence increasing the diffusion bonding. This work aims to investigate the effect of an atmospheric cold plasma treatment on the wettability and bonding of 3D printed objects. For this task, we designed an atmospheric pressure dielectric barrier discharge (DBD) plasma torch integrated on a commercial 3D printer. Thus, the device can be controlled to apply a plasma treatment while printing an object. As the deposition process will need to be done on complex surfaces and on thermal sensitive materials, a new type of high voltage nano-pulse generator had to be developed for this device. It gives the possibility to generate a homogeneous plasma (with less filament discharge) in a very small volume and a relatively extended plasma plume with a limitation of the gas temperature. Wettability measurements and tensile tests were carried out on 3D printed + plasma treated objects, obtained with our newly designed device. The material bonding is evaluated either within a single-material specimen by applying the treatment at the interlayers or within a multi-material one by treating only the interface layer of the two different materials.

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