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Innovative functionalized monofilaments for 3D printing using fused deposition modeling for the toy industry

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Abstract

FFF 3D printing technology will increase the toy industry innovation by means of the production of personalised toys through the development of new and innovative 3D printing filaments. These new materials have functional characteristics as colour change, antistatic or antimicrobial properties that will permit the production of short series which can be used in public places (hospitals or kindergartens) or areas of limited access such as hospitals. This works presents the developments of different polymeric material formulations and the characterisation with the aim to obtain new 3D printing filaments for customisation of toys and other consumer products.

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Keywords: 3D-printing, filament, FFF, conductive, antimicrobial.

1. Introduction

Given the attention that industrial companies have nowadays to AM, they consider to implement AM as a complementary production technique to manufacture innovative products. AM involves manufacturing a part by deposition of material layer by layer, which differs from conventional processes such as subtractive processes (e.g. milling or drilling), formative processes (e.g. casting or forging) and joining processes (e.g. welding or fastening) [1]. Among all AM technologies [2]: SLA, SLS, LOM, SI, 3DP, Laser LENS, FFF or FDM developed by Stratasys,

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FFF is the trendiest one, although already exists since the 80s. Currently, FFF is the technique showing high potential for product manufacturing, with the capability to compete with conventional polymer processing techniques [3].

Among the variety of applications where FFF technique can be used, as medical applications, aeronautics, automotive, electronic, design, traditional manufacturing sectors (e.g. toy, textile or shoes), toy industry is keen on the introduction of additive manufacturing in their production. In this sense, traditional sectors as toy industry needs to be improved by means of introducing new technologies and adapting to the new necessities and trends of customers. In this way, two scenarios are observed, being the first one, the introduction of the new manufacturing techniques as 3D printing (FFF technologies) which can increase the added value of toy products by adding new perspectives for the customers as product personalization. The second one is the 3D printing manufacturing of short products series of adapted products.

Related to the product customization, the iBUS project [4] aims to develop an innovative based business model for the sustainable supply of traditional toy products that is demand driven, manufactured locally and sustainably, meeting all product safety guidelines, within the EU. Thus, in this new model consumers become designers, designing, customizing and placing orders for their own products online in the iBUS cloud and manufacturers will then produce the furniture and toys in small scale series production driven by the actual customer demand. Finally, Suppliers will have visibility of, and make decisions based on, end-customer demand. According to the authors [5], this platform constitutes a business opportunity for the distributors of traditional toys, so they can learn first-hand the tastes and trends of users, strengthen their links with the consumer and also supplement their traditional activity. In reference to the customization capabilities of the customers, a study [6] performed based on the user's abilities to create their desired toy has distinguished among 5 levels of customization: personalization, configuration, in-store configuration, skeleton and free-form. The results revealed that among 65% and 94% of the parents, depending on the level of difficulty, have the required skills. For their children these results are among 49% and 66%, for children aged over 6, except for the free-form modality that is over 8 years old.

From the combined use of FFF 3D printing with intelligence materials capable of remove pathogens, appears the possibility to obtained customized or short product series of adapted products for kindergartens or children´s hospitals areas. Toys are very important for children in hospitals and are usually employed, both for enjoyment and for different therapies. However, for safety and infection control reasons, only new items that are washable, nontoxic and not easily broken are allowed in hospitals. Toys entering a hospital can be contaminated with potentially dangerous bacteria and may provide unnecessary risks for nosocomial (hospital-acquired) infection. Then, effective measures must be implemented to prevent the spread of infections via toys [7] and 3D printing with antimicrobial materials properties are an alternative to reach new child products to be used in this public places.

Against this background, we have developed new 3D filaments for being used in 3D printing for the toy industry with different properties to prepare customized products with color change or electrical conductivity properties or with antimicrobial properties to manufacture appealing customized products for children and for their used i.e., in hospitals or kindergarten, reducing the risk of infections. The present paper describes the most relevant results obtained.

Nomenclature

ABS	Acrylonitrile-Butadiene-Styrene
AM	Additive manufacturing
MWCNT	Multi-wall carbon nanotubes
FDM	Fused Deposition Modelling
FFF	Fused Filament Fabrication
ICP-MS	Inductively Coupled Plasma with Mass Spectrometry
LENS	Laser Engineering Net Shaping
LOM	Laminated Objet Manufacturing
MFI	Melt Flow Index
PC	Photo-chromic
PLA	Poly-lactic acid