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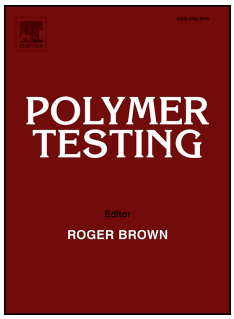

Wear mechanisms and abrasion rates in selective laser sintering materials

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Wear mechanisms and abrasion rates in selective laser sintering materials

Selective laser sintering offers very good mechanical material properties. The production in the powder bed gives total freedom in the layout without the need for support structures. One emerging application is the manufacturing of personalized shoes, be it for mass customization or in the medical field for patients with rheumatoid arthritis or later stages of diabetes. Because of this we are studying the wear and tribological behaviour of materials processed in this technology and we are looking for wear mechanisms that are unique to this process.
We compared thermoplastic polyurethane as well as the defacto standard polyamide 12 under different loading scenarios to elicit different wear mechanisms. To account for the layerwise production process specimens build in different orientations were investigated and compared.

Keywords: Additive Manufacturing; Selective laser sintering; PA12; Thermoplastic polyurethane; Wear; Tribology; Thermal effects;

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1. Introduction

Additive manufacturing allows for the affordable production of unique shapes. For polymers, especially selective laser sintering (SLS) offers good tensile and compressive material properties with a lower spread between different building orientations compared to fused deposition modelling[1] and a better temperature stability compared to stereolithography materials[1]. Lately SLS of shoes has become a focus of interest for many companies [a],[b],[c] as well as research:
Majewski et al. produced sporting soles from polyamide 12 (PA12) by SLS and tested their flexural characteristics [2]. Van der Zande et al. manufactured ladies heels from PA12[3]. And Vinet and Cain made traction spikes out of PA12[4].
Recently thermoplastic polyurethanes (TPUs) for SLS have been investigated as they offer elastomer-like mechanical properties as witnessed by Verbelen et al.[5]. These properties make TPU especially suited for additive manufacturing of shoes. Although many mechanical tests of selective laser sintering materials have been published ([1],[2],[5],[6]) only one paper has been published on wear properties of PA12 by Bai et al. who found an influence of the orientation on the wear rate[7]. No research on the wear of thermoplastic polyurethane and no comparison between SLS materials have been published to date.

One of the first to test the abrasion of polymers was Schallamach. He discovered the wave like abrasion patterns on the rubber[8]. An explanation for this was given by Southern and Thomas[9]. They reproduced the wave like patterns by using a blade abrader. The blade tears on small tongues of rubber, thereby

[a] https://www.fool.com/investing/general/2016/03/27/3d-systems-scores-second-big-win-3d-printed-shoe.aspx
[b] https://www.sculpteo.com/blog/2017/04/12/carbon-and-adidas-partnering-to-create-a-new-partly-3d-printed-shoe/
[c] https://www.shapeways.com/blog/archives/1938-nike-use-3d-printing-to-manufacture-the-vapor-laser-talon-football-shoe.html