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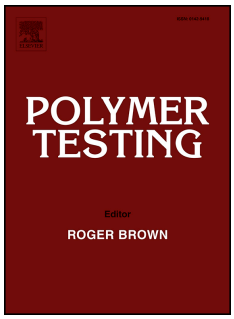

Tribological anisotropy of selective laser sintered PA12 parts

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Tribological anisotropy of selective laser sintered PA12 parts

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Abstract:

Additive manufacturing techniques like selective laser sintering (SLS) of polymers are on the verge from a pure prototyping technique to producing small lot sizes, as it enables the production of highly complex components without a mould. The parts are build layerwise and therefore the resulting components exhibit specific characteristics like anisotropic mechanical behavior, porosity and a high surface roughness. As SLS enables the production of whole assembly groups in one building step without the need of assembly, a missing factor is the tribological interaction of these parts. The scope of this paper therefore is to identify the influence of the building orientation on the tribological properties. The resulting anisotropic behavior is presented under different loads and in comparison to specimens produced in a pvT-device to point out the influence of the inner structure and surface of the parts during the different stages of a tribological interaction.

Keywords: selective laser sintering, tribology, anisotropy, building orientation, polyamide 12

1. Introduction

The development of new products always faces a conflict between the technical requirements, cost effectiveness and time-to-market. In addition, the importance of individualizing products has strongly increased because of mass customization [1]. Due to the increasing demand in individualizing products, additive manufacturing techniques have strongly emerged over the past decade. Even though there is a broad variety of additive processing techniques available, only a few of them fulfill the requirements for producing small lot sizes with desired properties and therefore possessing the ability to adapt to dynamic and complex markets [2]. For the use in industrial applications, properties of the resulting parts like mechanical behavior or reproducibility constitute important factors. In comparison selective laser sintering (sls) seems to fulfill these requirements best [3-5] due to its ability of producing more than just prototypes or demonstrators [6, 7]. With the increasing demand, the requirements like producing whole assembly groups in one step rise (e.g. rotational joints figure 1).

figure 1: rotational joint produced by sls in one step

To enable these fields of application the transferability of existing polymer tribological models onto SLS- parts is needed. Due to their specific anisotropic mechanical behavior as well as the high surface roughness, which is dependent on the orientation during the building process [8] and the inner structures like porosity [2], the transferability is questionable. This leads to the aim of this paper, which will investigate the tribological behavior of SLS-parts in dependence of the underlying wear mechanism, varying from adhesive to abrasive behavior depending on different surface roughness of the counterpart.

2. State of the art

The SLS-process is a powder bed based additive manufacturing technology which is divided in three main steps [9]. First, a blade or a roller distributes a new layer of powder onto the building platform during the powder coating stage. The most commonly used powder is Polyamide 12 (PA12) which has a main diameter ranging between 55-60 µm [5]. Afterwards, during the exposure stage, the cross-sectional area of the part is molten by a laser. In the last step, the powder consolidates and these three steps are repeated until the part is fully generated [10]. During the process the parts properties and layer attachment is mainly