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ORIGINAL ARTICLE

Using specially designed high-stiffness burnishing tool to achieve high-quality surface finish

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Abstract This paper is focused on the process of ball burnishing. The influence of tool stiffness on surface roughness parameters was considered theoretically, while experimental investigation was conducted to establish the influence of initial surface roughness (previous machining) on the effects of ball burnishing as the finishing process. Experimental investigations were conducted over a wide interval of most influential process parameters (burnishing forces, burnishing feed, and number of burnishing passes). The material used in the experiments was aluminum alloy EN AW-6082 (AlMgSi1) T651. Burnishing was performed using a specially designed tool of high stiffness. Statistical analysis of experimental data revealed strong correlation between roughness, R_a, and burnishing force, burnishing feed, and number of passes for the three surfaces, each with different roughness parameters. Particular combinations of process parameters yielded very low surface roughness, R_a, equivalent to polishing. It is worth noting that high surface quality can be achieved with relatively small burnishing forces, which differs from the investigations published so far. Contrary to conventional approaches, which are based on elastic tool systems, the authors propose the burnishing process to be conducted with high-stiffness tools. Further investigation shall be focused on optimization of burnishing process parameters in order to achieve surface finish equivalent to high polish.

Keywords Ball burnishing · Tool stiffness · Surface roughness

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1 Introduction

Surface roughness has a significant impact on performance of mechanical components [1]. Regardless of the machining or forming technology applied (turning, milling, grinding, rolling, casting, forging, etc.) processed surfaces of mechanical components always feature roughness, which directly impacts their interaction with the assembly [2]. Quality finishing has positive impact on the functioning of mechanical assemblies, power transmission, resistance to wear, corrosion, operating life of mechanical assemblies, and fatigue strength [3]. Conversely, inadequate finishing primarily inflates energy consumption, increases wear, and the risk of poor tolerances [4]. Among the most frequently used processes for the increase in surface roughness are fine turning and milling, grinding, polishing, honing, lapping, superfinish, etc. Another parameter that determines surface quality is surface microhardness, which largely influences wear resistance and fatigue strength. Alternative methods aimed at achieving higher wear resistance and fatigue strength are based on pure deformation strengthening [5]. Mechanical processes that are often used to increase fatigue strength are shot peening, hammering, water-jet peening, brushing, ballizing of bores, and autofrettage.

One of the finishing methods that does not rely on chip removal is ball burnishing. This method increases surface quality, surface hardness, and dimensional accuracy [6, 7]. In addition, it reduces surface defects and modifies