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ORIGINAL ARTICLE

Surface integrity of titanium part by ultrasonic magnetic abrasive finishing

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Abstract The surface integrity of titanium part is poor after milling; it is unable to meet the accuracy requirements for use. To solve this problem, the ultrasonic vibration-assisted magnetic abrasive finishing was proposed to be used for the surface finishing treatment. The finishing experimental result shows that the efficiency of ultrasonic magnetic abrasive finishing is 40 % higher than magnetic abrasive finishing. The milling texture on part surface faded or disappeared after ultrasonic magnetic abrasive finishing. The surface original micro-cracks have been completely removed. The surface stress state changed from the residual tensile stress 280 MPa before finishing to residual compressive stress 20 MPa after finishing. It verified that the ultrasonic magnetic abrasive finishing can efficiently promote the surface integrity of titanium parts and ultimately gain the best surface quality and performance.

Keywords Magnetic abrasive finishing · Machining efficiency · Ultrasonic vibration · Surface integrity

1 Introduction

With the rapid development of new technology machinery industry, the mechanical parts are facing the increasing demand for material performance. Because of the excellent physical and chemical properties, titanium material has been widely used in the aerospace industry, shipbuilding industry, automotive manufacturing, and many other fields [1]. But its superior performance also brings enormous difficulties to accurate machining. The titanium parts are usually formed by the five-axis CNC milling machine. Their surface will residual a large number of milling textures and micro-cracks due to the effect of squeezing from milling cutter, which seriously affects the stable operation of the parts in the mechanical system [2, 3]. To improve the performance and service life of titanium parts, accuracy machining needs to be done to the parts surface before use. The traditional grinding processes mostly belong to the rigid contact; they are easy to generate a lot of grinding heat and burn the part surface, and high accuracy machining trajectory is demanded for them [4, 5]. To finish this kind of special material parts, in the study of Yang-Zhi et al., the electrochemical process was applied to the surface finishing. The machining efficiency and accuracy are high [6]. But the process machining uniformity is effected by a variety of factors, and the machining result is instable. Even worse, it may pollute the environment; however, Yang Shen et al. used the electric discharge machining to manufacture the titanium alloy parts. Compared with the electrochemical way, this method can also gain a high machining quality [7]. But the machining efficiency is low relatively, and the process could easily lead to the surface internal stress increasing and part deformation; the machining dimensional accuracy is poor; it greatly affects the use of the part [8].

As a new finishing technology, magnetic abrasive finishing is using the magnetic abrasive particles as the cutting tool,

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