7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Evolution of surface topography in internal channels with abrasive flow machining (AFM) – WTC 2021, Lyon

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This study investigates the evolution of surface topography by a superfinishing process named 'abrasive flow machining' (AFM). The fundamental mechanism of AFM is micro-abrasion, which makes it close to a tribofinishing process. This study investigates the application of AFM on internal channels, that were produced by traditional manufacturing processes (machining) as well as additive manufacturing (selective laser melting, SLM). Their surface topography progress was characterized with contact and non-contact profilometer instruments, showing significant improvement of their surface roughness. Different material removal mechanisms, such as cutting and ploughing, are highlighted, that result in different surface topographies.

Keywords: surface topography, abrasive flow machining (AFM), internal channel

1. Introduction

Abrasive flow machining (AFM) has been used as a highly effective superfinishing/tribofinishing process of internal channel surfaces, such as conformal cooling channel for dies and molds. This study aims to investigate surface topography evolution of internal channel surfaces superfinished by AFM.

2. Methods

As shown in Figure 1, a cylinder of an AFM machine applies high pressure to AFM media, which is composed of polymeric carrier and abrasive grains, such as silicon carbide (SiC). The AFM media flows through an internal channel. Its surface material is removed by abrasion (e.g., cutting and plowing) between the grains and channel surface.

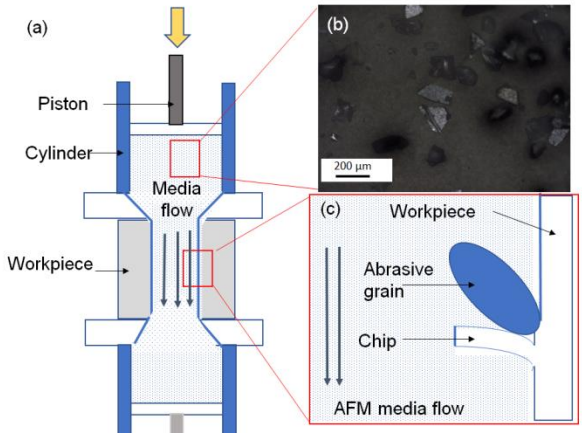

Figure 1: Schematic illustration of AFM process in an internal channel of a workpiece [1].

The AFM process can be applied to internal channels produced by conventional manufacturing processes, such as drilling and milling, or by non-traditional manufacturing processes, such as electrical discharge machining (EDM) and additive manufacturing processes (selective laser melting, SLM).

3. Discussion

Figure 2 shows surface topography evolution of an SLM conformal channel surface by AFM.

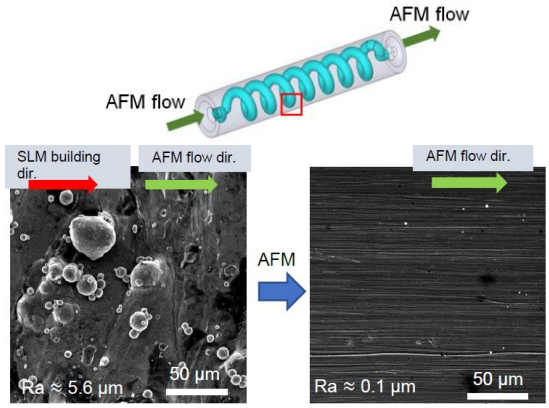

Figure 2: Surface topography evolution of SLM conformal channels with AFM [2][3].

The surface topography evolution was found to be sensitive to media parameters, such as abrasive grain size and its concentration, showing that underlying material removal mechanisms can be different. In addition to topography evolution, different material removal mechanisms gave birth to different surface integrities, such as residual stress profiles under the surface, affecting its fatigue performance.

4. References

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