Practical implementation of laser polishing of additively manufactured medical implants

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Additive manufacturing is gaining popularity due to the flexibility of the build process and ability to create complex 3-dimensional components without adding complexity to the manufacturing process. However, for most applications, the as-built surface quality is rarely sufficient and usually requires some additional post-processing steps to improve this. Currently employed post-processing methods include electrochemical and mechanical (abrasive) polishing, each with their own downsides. Electrochemical polishing is a non-selective process that works well for complex geometries, although requires masking (or further post-processing) to obtain multiple surface finishes. Mechanical polishing however is difficult to achieve with complex shapes, requiring highly skilled workers, and processing time increasing with complexity.

Laser polishing uses a laser beam to create a small melt pool on the surface of the material. The surface tension drives the molten material from the peaks to the valleys, therefore reducing the surface roughness without removing material. This non-contact process can potentially provide shorter processing times than electrochemical and mechanical polishing with improved repeatability. Additionally, the absence of hazardous chemicals or abrasives delivers a more environmentally friendly process.

In this work, we show practical methods for implementing a laser polishing process to improve the surface quality of additively manufactured titanium alloy (Ti6Al4V) and cobalt chrome medical implants. Using simple optical setups, we overcome the challenges of height variation affecting the laser energy density delivered to the part surface, as well as ensuring a continuously polished area for cylindrical-like parts. We also present an optical setup to deliver the laser to internal surfaces of hollow cylindrical parts. We have investigated the effect of laser polishing on material properties and found no impact compared with the as-built parts on the tensile properties.