Direct Metal Laser Sintering-New Possibilities in Biomedical Part Manufacturing

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Abstract

Direct Metal Laser Sintering (DMLS) has been utilized for prototype manufacturing of functional metal components for years now. During this period the surface quality, mechanical properties, detail resolution and easiness of the process have been improved to the level suitable for direct production of complex metallic components for various applications.
The paper will present the latest DMLS technology utilizing EOSINT M270 laser sintering machine and EOSTYLE support generation software for direct and rapid production of complex shaped metallic components for various purposes. The focus of the presentation will be in rapid manufacturing of customized biomedical implants and surgical devices of the latest stainless steel, titanium and cobalt-chromium-molybdenum alloys. In addition to biomedical applications, other application areas where complex metallic parts with stringent requirements are being needed will be presented.

Keywords: rapid manufacturing, biomedical implants, laser sintering

1. Introduction

Laser-sintering technologies were originally applied principally to rapid prototyping (RP), and Direct Metal Laser-Sintering (DMLS) to rapid tooling, especially for prototype tooling. Over the years the range of applications has increased to cover methods for batch size optimized manufacturing in all phases of the product life cycle, i.e. including prototyping, production and even spare parts.

The latest development in laser sintering machines was the introduction of a new EOSINT M270 machine. EOSINT M 270 is a new laser-sintering machine concept based on a solid-state, dual focus laser and redesigned mechanics enabling a faster laser-sintering process with higher detail resolution than previous EOSINT machines. Moreover, the M 270 provides a more efficient platform for current DMLS materials and especially for ongoing development of new powders and processes for a wider spectrum of future applications. The ytterbium fibre laser used in the EOSINT M 270 has a beam quality M^2 of almost 1.0, which enables it to be focussed down to around 100µm (0.0040 in.) beam diameter over the entire 250 mm x 250 mm build area, which with 200 Watt power corresponds to an average power intensity of up to 25 kW/mm². This laser also has a shorter wavelength than CO_2 lasers, giving higher absorption in metals and therefore resulting in higher effective power and enabling higher build speeds. The variable laser focus feature enables a very fine focus for best possible detail resolution to be combined with fast, efficient exposure of large areas by using a defocused, i.e. broader laser beam.

Fig. 1. EOSINT M270 laser sintering machine

2. DMLS in Rapid Manufacturing of biomedical parts

During the last years more and more complex components have been manufactured using DMLS as a production method. In the beginning, most of these components were intended for rapid prototyping purposes, but as the experience accumulated, more parts have been

manufactured for final assemblies and even spare parts. Typical geometries that can be laser-sintered are conventionally produced by PM compacting, casting or cannot be produced at all. In fact, the trend now seems to be that for some cases the conventional production methods are replaced by DMLS. Several applications require only a few components that would be very expensive to manufacture by conventional means. In these cases the parts could be produced by DMLS in a few days without any tooling.

The benefit of the process is that individual biomedical implants or dental restorations can be manufactured directly from 3-dimensional scanned data. Figure 2 presents biomedical implants manufactured of CobaltChrome MP1 by EOSINT M270.

Fig. 2. Artificial knee joint. Laser sintered of biocompatible CobaltChrome MP1 alloy in EOSINT M270.

In dental application area dental restorations and bridges can be manufactured from data received from dental scanner. After laser sintering the restorations and bridges will be shot-peened, snapped off the support and finished by ceramic coating. Figure 3 presents 198 dental unique restorations on building platform and final restorations after coating with ceramic.

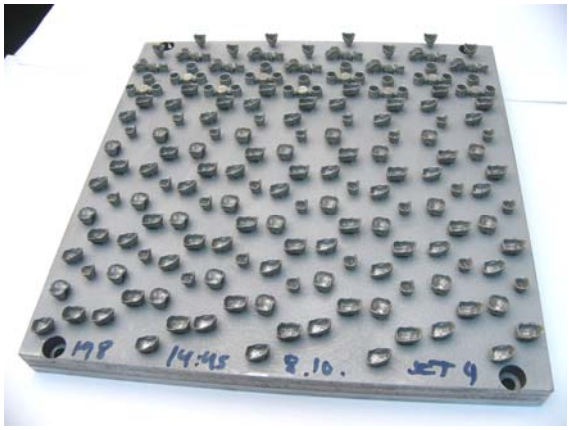

Fig. 3. 198 dental restorations on building platform. Laser sintered of dental Cobalt Chrome SP1 alloy in EOSINT M270.