

Advances in metal additive manufacturing for dentistry: Review

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3D printing, or additive manufacturing, has technologically exploded in the last few years. Improved accuracy, increased efficiency, lower cost, smaller units and novel materials have significantly changed the fabrication landscape. Dentistry is currently experiencing a trend toward 3D printing. Implant dentistry was one of the first disciplines to experience 3D printed guides for predictable surgeries. A revolution in materials and technologies has resulted in further evolution, including the printing of prosthodontic frameworks, dentures and implant components. Recent advances in industrial metal printers and materials have resulted in a surge in the applicability of metal additive manufacturing applications for dentistry. This presentation will explore the exciting advancement of metal AM, including the AM process, established and novel workflows, and applications. Specific applications will be presented, including the novel workflow for dental abutment fabrication and reverse engineered only restorations. The objectives are for the participant to appreciate fundamentals of 3D printing, understand the workflow and current materials and identify clinical applications of 3D printing.

3D printing has been hailed as a disruptive technology which will change manufacturing. Used in aerospace, defence, art and design, 3D printing is becoming a subject of great interest in surgery. The technology has a particular resonance with dentistry, and with advances in 3D imaging and modelling technologies such as cone beam computed tomography and intraoral scanning, and with the relatively long history of the use of CAD/CAM technologies in dentistry, it will become of increasing importance. Uses of 3D printing include the production of drill guides for dental implants, the production of physical models for prosthodontics, orthodontics and surgery, the manufacture of dental, craniomaxillofacial and orthopaedic implants, and the fabrication of copings and frameworks for implant and dental restorations. This paper reviews the types of 3D printing technologies available and their various applications in dentistry and in maxillofacial surgery.

Additive manufacturing is the perfect solution to get customized items, for all sectors. But it becomes even more relevant when it comes to the medical sector, as it allows great realizations such as prosthesis.

In the healthcare field, some solutions have to be adapted to the patients. Typically, prosthesis or implants have to match with the patient's morphology. And it is also particularly true for dentistry,

because everybody has his own dentition, all patients' mouths are different. It is now possible to get an accurate 3D model of the patient's dentition, that will lead to 3D dental restoration, with solutions totally adapted to the patient.

Dental 3D printing is the key of modern dentistry, as it is really helpful for dental labs. Digital dentistry is wide-spreading quite fast in the industry for many reasons. Like we said, it is an easy way to get customized items. Moreover, it is a cost-effective and time-saving method. For example, if your 3D printed device doesn't fit, you just have to modify your 3D design.

Additive manufacturing also has an important role in dental implant surgery. It is actually possible to create a 3D model to replace a missing tooth. Indeed, 3D printing allows to get a replacement tooth faster and with more accuracy than with traditional methods. It is also an easier and economical method, and the final product can have a really good finish. 3D printing and dental restoration have a bright future together to come.

In China, an autonomous 3D dental implant intervention has been managed by the Dr Zhao Yimin. This oral rehabilitation professional created a robotic dentist, able to lead an implant surgery by itself. This impressive surgery took an hour long and was a real success.

It is also possible to 3D print complete dentures, with gum and teeth, that have to be printed with biocompatible materials. Indeed, even the denture base is 3D printable and can be adapted to the patient's morphology. For the moment, 3D printed dentures are only created for clinical tests, but we assume that it will be a common 3D printed product really soon.

Additive manufacturing allows to produce crowns very quickly, as the process can be done by the dentist by himself. It is one of the most common applications of 3D printing in dentistry. It is possible to get a scan of the patient's teeth, to model it and to directly print the crown. This process is really time-saving, and the professional can modify and reprint the crown if there is a mistake.

Of course, this is not an exhaustive list of what you can 3D print in the dental industry, it is also possible to 3D print surgical devices, night guards, and so on.

3D printing can also be used for the professionals themselves. Indeed, it is possible to 3D print not only braces, biocompatible surgical guides, implants or crowns, but also tools. This way, it is possible to adapt perfectly the devices to the working methods, or processes. This method to produce tools is usable for all the medical industry.