Risk of Fire in Digital Dentistry

The advances in additive manufacturing (AM, also termed 3D Printing) have allowed lab and chairside capabilities that can quickly create high-precision dental models, restorations and prosthetics. The ability to produce an accurate scan that converts to a 3D file allows dentists and lab technicians to create dental models, castings, implant guides, and prosthetics that match the dimensions and characteristics of the patients' own teeth and jaw structure to give them a more natural look.

There are FDA-approved 3D printable resins, alloys and ceramics that can be utilized in material extrusion and powder bed processes. The combination of certain materials and equipment can present a fire risk in the laboratory and possibly in the dentists' offices as well.

Most personal 3D printers use material extrusion technology to print the devices. In this process, a plastic resin is fed into an extrusion tip and melted into a bead of plastic that can be printed into thin layers to gradually build the item. The extruded plastic is melted at a high temperature. If the temperature of the print head is not properly controlled, it can exceed the normal processing temperatures and potentially overheat. Generally, the design, construction and built-in safety features of a 3D printer allows for safe production of 3D parts without the risk of fire, even under overheating conditions.

Another potential fire hazard is the waste powder resulting from powder bed processing. It is not typically a large quantity of powder waste, but it is powder, and powdered metal in that state can be explosive. Methods of handling, storage, clean-up and disposal are critical to controlling the fire potential – the accumulation of metal powder waste on lab equipment/fixtures/floors and any potential for airborne metal powder "dust" must be minimized.

While some of the fire safety issues share a commonality with general machine shop/build-lab safety concerns, there are very specific safety measures that should be taken in an AM environment that are not normally put into practice in general laboratory processing.

There are documented cases of fires resulting from 3D printers. Typically these incidents are primarily due to unintended conditions, such as aftermarket modification of the machine, or ***use of materials of a grade not specified by the manufacturer***. Like most machinery, leaving a machine unattended during operation is not recommended, especially if the build is one that takes several hours.

Static electricity and fire: In processes involving powdered metal, static electricity is also a concern. If there is a static arc, then the metal becomes reactive. It is not uncommon to have a metal fire inside a 3D printing machine. Almost anything in powder form with static in the air and the right ignition source can catch fire.

To help prevent fires from happening, UL (Underwriters Laboratories, the premier safety authority for AM) recommends certain elements of an electro-discharge safety program. This program should include

having all machines static grounded; using anti-static mats that are grounded to the machine's frame; using statically grounded vacuum cleaners; applying an anti-static coating to floors; and requiring that everyone wears anti-static shoes.

Because static electricity can lead to fire, the type of fire extinguisher that is readily available in the vicinity of an AM operation also is important. Most laboratories have A, B and C Class fire extinguishers on hand, but ***AM metals, which are combustible, require a Class D extinguisher.***

"Metal fires represent a unique hazard because people are often not aware of the characteristics of these fires and are not properly prepared to fight them," according to UL. "Even a small metal fire can spread and become a larger fire in surrounding ordinary combustible materials. Only an extinguisher specifically made for metal fires should be used, and professional training is needed to effectively fight them."

For the fires that could result from the resin or polymer extrusion processes, class B: C extinguishers should be used. A Class B fire is one that involves flammable and combustible liquids (this includes the molten plastics used in AM) and a Class C fire is one that involves flammable gases and electrical fires. Given the prevalence of electronic devices in most labs and offices, a Clean Agent (FM200) extinguisher would be the best choice. This type of extinguishing agent quickly suppresses B and C fires and does not damage any electrical or electronic equipment.

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