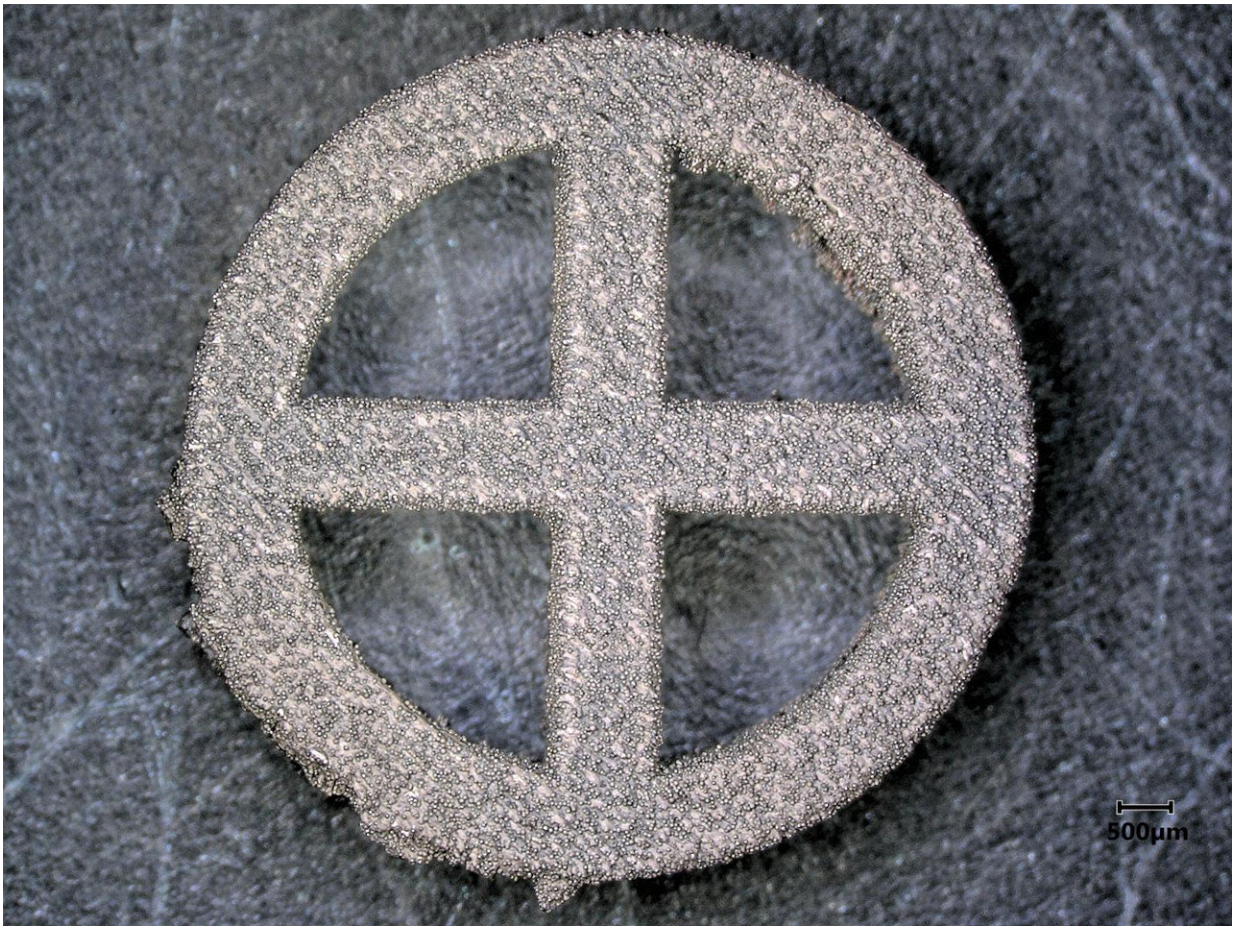
# Researchers bring the bling to improve implants

March 13 2018




A diamond coated 3-D printed titanium disc. Credit: RMIT University

In a world first, Australian researchers have harnessed the power of

diamonds in a breakthrough that could lead to radical improvements in the way human bodies accept biomedical implants.

Researchers from RMIT University have for the first time successfully coated 3D printed titanium implants with diamond.

The development is the first step toward 3D printed diamond implants for biomedical uses and orthopaedics—surgical procedures involving the human musculoskeletal system.

While titanium offers a fast, accurate and reliable material for medical grade and patient-specific implants, our bodies can sometimes reject this material.

This is due to chemical compounds on titanium, which prevent tissue and bone from interacting effectively with biomedical implants. Synthetic diamond provides an inexpensive solution to this problem.

The breakthrough has been made by biomedical engineer Dr Kate Fox and her team at RMIT's School of Engineering.

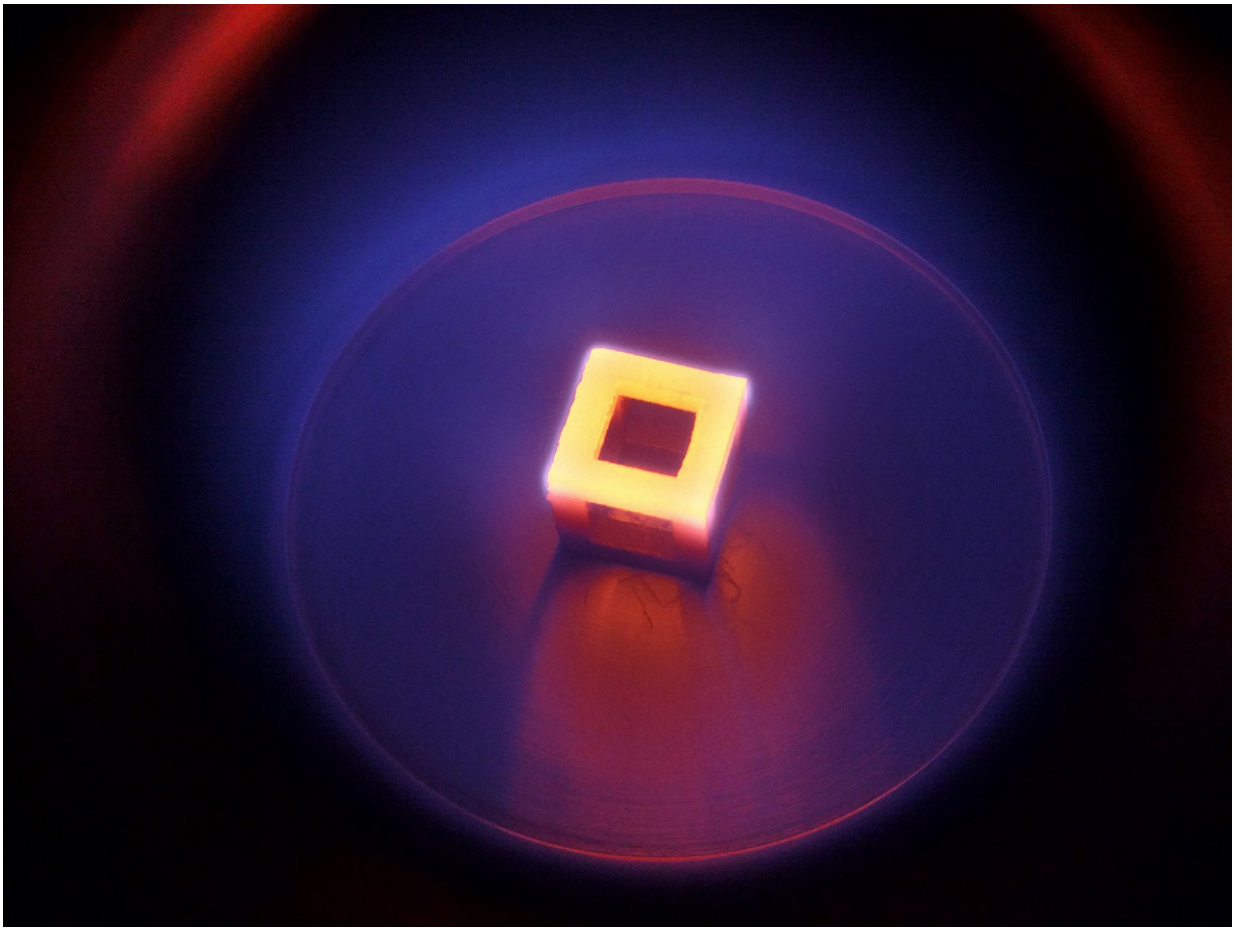
"Currently the gold standard for medical implants is titanium but too often titanium implants don't interact with our bodies the way we need them to," Fox said.

"To work around this, we have used diamond on 3D scaffolds to create a surface coating that adheres better to cells commonly found in mammals.

"We are using detonation nanodiamonds to create the coating, which are cheaper than the titanium powder.

"This coating not only promotes better cellular attachment to the

underlying diamond-titanium layer, but encouraged the proliferation of mammalian cells. The diamond enhances the integration between the living bone and the artificial implant, and reduces bacterial attachment over an extended period of time.



3-D printed titanium in a CVD plasma chamber. Samples glow due to the heat of the microwave plasma, once removed the titanium will have been coated with diamond. Credit: RMIT University

"Not only could our diamond coating lead to better biocompatibility for 3D-printed implants, but it could also improve their wear and resistance.

It's an exceptional biomaterial."

The breakthrough was made possible with recent advances in the 3D printing of titanium scaffolds at RMIT's Advanced Manufacturing Precinct. The coating is created via a microwave plasma process at the Melbourne Centre for Nanofabrication. The titanium scaffolds and diamond are combined to create the biomaterial.

"It will be a number of years before a technology like this is rolled out, and there are many steps to take until we see it available to patients," Fox said. "But what we have done is taken the first crucial step in a long and potentially incredible journey."

PhD researcher Aaqil Rifai, who is working on the new technology with Fox, said diamond is so effective because carbon is a major component of the human body.

"Carbon has an incredible level of biocompatibility," Rifai said. "Our body readily accepts and thrives off diamond as a platform for complex material interfacing."

In addition to orthopaedics, diamond has also been used to coat cardiovascular stents - tubes that help keep the heart's arteries open - and on joints, as well as in bionics and prosthetics.

For now, the researchers are concentrating on how the technology can be used for orthopaedics.

"3D printing is a groundbreaking revolution in the modern era. With 3D printing we can design patient specific implants of medical grade. The technology is fast, accurate, reliable and saves labour time," Rifai said.

"The scalability of 3D printing is growing rapidly, so we can expect to

see diamond coatings to become common in orthopaedics sometime in the near future."

The breakthrough has been reported in *ACS Applied Materials and Interfaces* and involved researchers from a range of disciplines at RMIT and other Australian universities.

**More information:** Aaqil Rifai et al, Polycrystalline Diamond Coating of Additively Manufactured Titanium for Biomedical Applications, *ACS Applied Materials & Interfaces* (2018). DOI: 10.1021/acsami.7b18596

Provided by RMIT University