Scientists create 3-D printed parts that can kill bacteria

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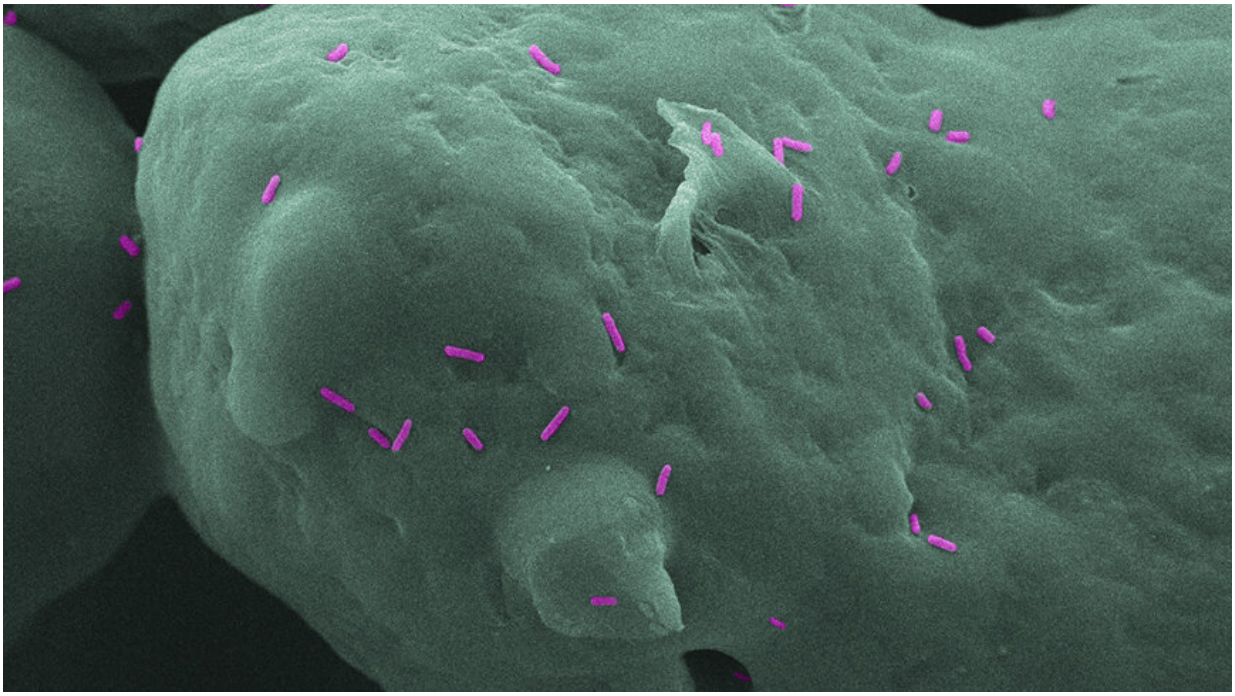

Individual bacteria on a Nylon-12 surface. The bacteria is Pseudomonas aeruginosa, which can cause disease in plants, animals and humans. Credit: University of Sheffield

Researchers from the University of Sheffield have, for the first time, manufactured 3-D printed parts that show resistance to common bacteria. This could stop the spread of infections such as MRSA in hospitals and care homes, saving the lives of vulnerable patients.

The study was published today (21 January 2020) in *Scientific Reports* by an interdisciplinary team of researchers from the University's Department of Mechanical Engineering and the School of Clinical Dentistry. The research combined 3-D printing with a silver-based antibacterial compound in order to produce the parts.

Results from the research have shown that the anti-bacterial compound can be successfully incorporated into existing 3-D printing materials without any negative influence on processability or part strength, and that under the right conditions, the resultant parts demonstrate anti-bacterial properties without being toxic to human cells. Further work is ongoing to investigate the full extent of this capability.

The findings offer the potential for applications in a wide range of areas, including medical devices, general parts for hospitals which are subject to high levels of human contact, door handles or children's toys, oral health products (dentures) and consumer products, such as mobile phone cases. Further projects are planned in each of these areas, with an aim to work with leaders in industry and the potential to bring some of these products to market.

Dr. Candice Majewski, lead academic on the project, who works in the Centre for Advanced Additive Manufacturing in the Department of Mechanical Engineering at the University of Sheffield, said: "Managing the spread of harmful bacteria, infection and the increasing resistance to antibiotics is a global concern. Introducing antibacterial protection to products and devices at the point of manufacture could be an essential tool in this fight.

"Most current 3-D printed products don't have additional functionality. Adding antibacterial properties at the manufacturing stage will provide a step-change in our utilization of the processes' capabilities."

Products such as medical devices are often already coated with an antibacterial compound and are subject to strict and rigorous cleaning or sterilization procedures. However, whilst this provides a certain level of protection, they have their limitations, such as human error in cleaning or damage occurring to the coating.

Rigorous testing and imaging techniques were carried out to establish the effect of the antibacterial additive—looking at the effect on the quality of the final part, its mechanical properties and whether it survived the manufacturing process.

Parts with and without the antibacterial additive were submerged in various bacterial solutions to test how many bacteria remained after 24 hours. Parts containing the antibacterial additive were effective against examples of the two main groups of bacteria, Gram positive (Staphylococcus aureus) and Gram negative (Pseudomonas aeruginosa), both of which can cause many different types of infection.

An additional effect was identified in reducing the number of bacteria stuck to the part surfaces. Bacteria stuck to surfaces form 'biofilms' that are often difficult to remove; in this case an anti-biofilm effect was observed, due to bacteria dying before they could stick to the parts. Parts worked less well in liquid containing lots of nutrients—these were found to interfere with the silver before it could do its job. This will help people decide what environments to use this technology in. Finally, parts were also tested with human cells (routinely grown in the lab) and found to have no toxicity.

Dr. Bob Turner from the University's Department of Computer Science, added: "Our interactions with microbes are complex and contradictory—they're essential to our survival and they can knock us dead. Technology like this will be key to informed and sustainable management of this crucial relationship with nature."

This research involved collaboration with microbiologist Dr. Joey Shepherd from the University's School of Clinical Dentistry, who said: "Incorporating antibacterial activity into 3-D printed parts is an intriguing novel direction only made possible by working as part of a great team with complementary skills and experience."

The study, "Use of silver-based additives for the development of antibacterial functionality in laser sintered polyamide 12 parts," is published in *Scientific Reports*.

More information: Robert D. Turner et al. Use of silver-based additives for the development of antibacterial functionality in Laser Sintered polyamide 12 parts, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-57686-4

Provided by University of Sheffield