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Direct 3D printing of two-component silicone

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Technology description

Summary
The system being developed by a team led by a King’s College London researcher is unique in its ability to 3D print a biocompatible two-part silicone required for medical devices such as facial/body prostheses. Silicone formulations have been developed and printed using a modified 3D printer with a custom print head to print room-temperature curing silicone objects with properties similar to those required for prostheses.

What

A 3D printing system (including a mixing print head, silicone "ink" formulations and associated control software) has been developed that will directly print patient specific body/facial prostheses using digital images of the defect. The innovation is expected to significantly reduce the time taken to make prostheses and also reduce the number of clinical appointments and provide a more reliable result. It will achieve better reproducibility and is expected to allow a better match to the patient’s skin colour and texture than is presently achievable making the prosthesis less noticeable.

Why

Facial/body prostheses are often required for patients who have lost facial/body parts, such as an ear, nose, eye, finger, hand or breast or combinations of these. These defects can result from trauma, congenital malformations or diseases such as cancer. Improvements in medicine, surgical techniques and in particular cancer survival rates are resulting in increasing numbers of patients who require prostheses.

Typically, facial/body prostheses are manufactured by a lengthy multi-step process that involves taking an impression from the patient, hand carving the missing defect, creating a two or three part stone mould into which pigmented silicone is placed, colour matched to the surrounding tissue. These methods of prosthesis construction are time-consuming, involving five to six patient visits and results are dependent on the skills of the prosthetist.

Opportunity

The ability to 3D print biocompatible silicone presents a number of potentially significant product opportunities. The greatest of these include patient-specific devices, such as:

- body surface prostheses to replace missing non-articulated body parts (nose, ear, cheek, breast etc.);
- coverings for prosthetic limbs;

• anatomical models to enable surgeons to improve pre-operative planning, simulation and teaching prior to complex surgical procedures (e.g. correcting congenital abnormalities or reconstructing following trauma);
• custom fingers for advanced soft robotics;
• biocompatible in vivo medical devices or medical device components, where advanced silicones or variable hardness would be appropriate.

Dr Coward, a Reader in Maxillofacial and Craniofacial Rehabilitation at King’s, was motivated to develop the technology by the desire to produce directly silicone prosthetic objects from medical images. Funding for the invention and some subsequent development was provided by Dstl, the UK Ministry of Defence’s research agency, with the aim of improving treatment options for trauma victims. Collaborators in the invention were Dr Jim Smay of Oklahoma State University (responsible for the design of the mixing print head for silicone printing and its control software) and Prof Mark Waters of Technovent Ltd (developing suitable biocompatible room-temperature curing silicone formulations). Prof Waters and Dr Coward continue to collaborate on refinement of the technology.

Institution

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