3D printing in the development of the endoscopic probe

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Optical fibers are commonly used for sensing and imaging purposes of the organs of human body in a minimally invasive or non-invasive manner [1]. Recent development of miniature fiber-based probes has a great potential for imaging purposes in medicine [2]. The needle stylet with integrated optical fibers have been demonstrated for infrared spectroscopy [3,4]. The combination of integrated optical fibers with needle stylet and photoacoustic technology would provide further opportunity for imaging of organ and deep tissue which other way wouldn't be possible. For this purpose fibers have to be inserted insight of the procedure needle fixed and constrained against movement. Avoiding cross talk between the fibers they have to be keep apart at some distance. Three-dimensional (3D) printing or rapid prototyping (RP) technology has been widely used in the varieties of scientific areas: biotechnology, medical science, chemistry, dentistry and others [5–9]. The direct formation of the object (layer by layer in sub mm scale), freedom in object design, multi-material printing, and minimum lost material during production are some of the interesting capabilities of 3D printing. It provides an opportunity for engineers to create unique complex structures, visualize the designed objects before the construction and eliminate errors, and saving material. The knowledge of printing accuracy (resolution) of small parts is required.

In this context the feasibility of 3D printing technology for the development of endoscopic probes is assessed. We will demonstrate the latest progress in development of endoscopic probe with help of 3D printing.

Two polyjet printers (Objet 30, Objet 350 Connex) have been used with highest printing resolution possible for fabrication of a number of cylindrical objects (stylets) with diameters (0.6 mm-3 mm) with holes. The tip of every stylet was tilted 22 degree from z direction similar to the needle. The accuracy of printing using two polyjet printers is compared. Multi-material printing, the orientation of printed objects and different printing regimes (gloss and mate) influences on final 3D printing output will be discussed. The minimum outer diameter of the stylet 460 μm is achieved, while the holes in stylets as small as ~400 μm are created. The minimum wall thickness for small objects in the range of 500 μm is achieved. To keep fibers fixed at proximal end of the needle a novel custom made fibers-needle connector was developed. This connector simplifies the clamping of the fibers and connection to the needle. The future potential of incorporating endoscopic probe into interventional imaging system will be discussed.

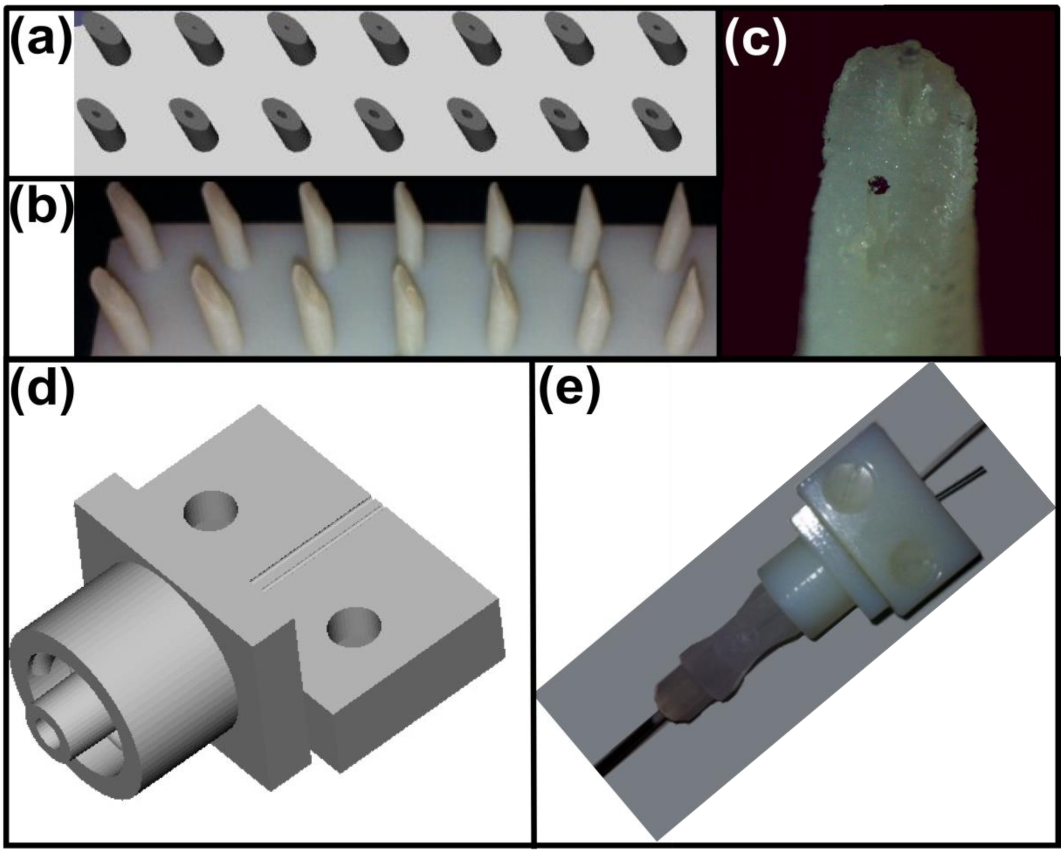

Figure 1. (a) 3mm cylinder objects (stylets) with 22 degree at the tip are designed in FreeCAD software, and (b) fabricated using 3D printer by Objet 30 Stratasys printer from VeroWhitePlus material. (c) The possibility of two 125 μm fibers to keep apart using 3D printed stylet at the proximal end of the needle is demonstrated. (d) A fibers-needle holder is designed with grooves for fibers and a luer for the needle connection, and (e) fabricated by polyjet printer Object 30.

Keywords

3D printing, optical probe, needle stylet

Biography

Daniil Nikitichev has earned a PhD degree from University of Dundee in 2012 in Laser Physics designing, developing, constructing and testing the range of lasers. After few months at Aston University and Swansea University characterizing fiber lasers and amplifiers, he joined the University College London in London, UK. He has been working with a photoacoustic ultrasound system for ex-vivo and in-vivo imaging of the tissues and organs. Last year he was fascinated by

3D printing technology and its possibilities. His research topics include 3D printing, acoustic properties of 3D printed materials, photoacoustic imaging, optical and photoacoustic phantoms.

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