INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis title

Development of Porous and Patient-Specific Shape Memory Polymer Composites as an Embolic Agent for Endovascular Embolization

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SHORT ABSTRACT

The objective of the present work is to develop a radiopaque, porous, and patient-specific shape memory polymer (SMP) based embolizing agent for interventional radiology technique that overcomes the limitations of the currently used embolic agents. In this regard, a novel fabrication technique has been developed by combining extrusion, fused filament fabrication (FFF), and salt leaching process to produce the patient-specific porous composites. Initially, tungsten (7wt%) as a radiopaque filler and NaCl (43wt%) as a pore-forming agent are dispersed in acetone and mixed with shape memory polyurethane (SMPU) (50wt%) to obtain the coated polymer pellets, which are extruded to produce the filaments to be used in FFF process. The FFF printing process is used to fabricate the shape memory polyurethane composites (SMPC) having the desired shape, and the NaCl particles are leached out to produce the porous structure. The 3D printed porous Tungsten composite has the following features: improved radiopacity, porosity of about 32.7% with pore sizes of <250 μm, interconnected porous network, and excellent shape holding and shape recovery characteristics up to 100%. However, the tungsten used in the porous SMPC is oxidized during the shelf aging period, and its cytotoxic behaviour is also observed during the biocompatibility studies. Based on the different characterization techniques and the biocompatibility studies, the nano $BaSO_4$ (10wt%) is found to be a suitable radiopaque material to fabricate the 3D printed SMPU composites by the novel processing technique. The higher albumin: fibrinogen (A:F) ratio of the nano $BaSO_4$ composite in the protein adsorption test compared to SMPU predicts a lesser probability of thrombosis in the composites, which enhances its suitability for a blood-contacting medical implant. The storage modulus of the 3D printed porous nano $BaSO_4$ SMPC in the rubbery state is observed to be in the similar range of the elastic modulus of the wall of an abdominal aortic aneurysm, which makes it suitable for the embolization process. The viability of the deployment of SMPC in an aneurysm is successfully tested in an in-house developed aneurysm simulator, and the 3D printed nano $BaSO_4$ SMPC is observed to recover completely within the aneurysm.