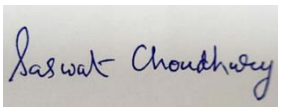
Summary of work

The advancements in biomaterials and additive manufacturing have ushered in a new era of personalized medical devices. Though 3D (three-dimensional) printing has made great strides in realizing customised medical devices, it still suffers from serious limitations, such as realizing complex shapes. To circumvent these issues, 4D (four-dimensional) printing emerged, where the printed structures are responsive to certain stimulus that allows them to change their shape (and/or properties) with time (the fourth dimension). This work aims to utilize biopolymers and thermoplastics for creating resorbable medical devices for *in situ* deployment. In the first part, hydrogels of alginate and methyl cellulose of different compositions were 3D printed into different layers that could self roll from a flat sheet into hollow tubes owing to the differential swelling across layers. These moisture responsive hydrogels were used as sutureless nerve guidance conduits (NGCs), wherein the flat sheet placed across severed nerve ends could roll into a tube upon exposure to moisture, thereby clamping the nerve ends together, without requiring sutures. These NGCs were shown to aid in neural regeneration in a sciatic nerve defect model in rats. In the second part, a shape memory polymer (SMP), namely polylactide-co-trimethylene carbonate (PLMC) was incorporated with iron oxide nanoparticles to make SMP composites (SMPC) that are responsive to alternating magnetic field. The composites were 3D printed into different shapes, including scaffolds that could aid in hard tissue regeneration. The as-printed scaffolds, when deformed into temporary shapes to be deployed in a minimally invasive manner, could recover back to their original shapes with magnetic stimulation. This serves as a benign, fast, contactless and safe deployment strategy that could be utilized in a wide range of implantable medical devices.

Saswat Choudhury



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