INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Understanding Viscoelastic Behavior of Drug Carriers and Fabrication of Microdevice for Cancer Therapeutic Applications

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SHORT ABSTRACT

Flow-through constricted microchannels are essential in engineering applications like inkjet printing, droplet microfluidics, and biomedical engineering. It is believed that a microfluidic-based study can address one of the most serious concerns of the present world: targeted cancer therapeutics Thus, the work discussed in the thesis involves a microfluidics-based study on targeted cancer therapeutics, particularly on understanding the transport of drug carriers and cancer cells through microchannels designed to mimic blood capillaries. Much of the thesis work involved developing and fabricating constricted microchannels that mimic the confinement of blood capillary networks. Another significant portion of the research included designing an experimental and numerical setup for deciphering flow dynamics and deformation of drug carriers and cancer cells flowing through microchannels of a minimum width of 7 μm. In the first investigation, a viscoelastic drop model was created to understand these drug carriers' elastic and shear-thinning behavior, which is somewhat difficult to discern through experiments. Basilisk, a finite volume-based open-source solver, was used to simulate the two-phase Newtonian-viscoelastic drop-matrix system. The simulation study on the viscoelastic drop model of drug carriers gave significant insights into their deformation and breakup behavior when they flow through constricted microchannels. The effect of viscosity ratio, confinement ratio, and capillary number on drop breakup can be used to design the drug delivery system for achieving on-demand burst release from the drug carriers. Another independent study observed that hydrogel carriers showed better structural healing and mechanical strength than nanovesicles, while nanovesicles are more bio-compatible than hydrogel carriers. The insights from the study can be useful in predicting the relaxation time of these drug carriers. Furthermore, another study on the flow of protein-bound paclitaxel inside a constricted microchannel revealed that shear-induced aggregation plays a vital role in particle aggregation in extremely confined flow. Finally, a drug-screening microdevice was fabricated to correctly estimate the drug uptake on MCF-7 cells. The drug uptake inside the microchannel was 1.78 times higher than in comparison to the static condition.