INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	SURJENDU MAITY
Roll Number	:	166153003
Programme of Study	:	Ph.D.

Thesis Title: TRANSPORT, SENSING AND MIXING OF NANOSCALE OBJECTS IN MICROFLUIDIC REACTORS.

Name of Thesis Supervisor(s)	:	DR. DIPANKAR BANDYOPADHYAY
Thesis Submitted to the Department/ Center	:	CENTRE FOR NANOTECHNOLOGY
Date of completion of Thesis Viva-Voce Exam	:	06-07-2021
Key words for description of Thesis Work	:	Microreactor, conversion, point-of-care-technology (POCT), *in-vitro*, drug delivery, microfluidic-immunosensor, micro/nanofiltration membranes, death kinetics, cellulose acetate.

SHORT ABSTRACT

Miniaturization of the macroscopic technologies has been one of the most attractive areas of research and development in the recent years. For example, the miniaturized processes are now extensively employed for synthesis of materials, health care diagnostics and therapeutics, renewable and non-renewable energy harvesting, environmental remediation, biotechnology, electronic devices, and materials-electrical-morphological characterization. In this regard, although the progress has been very rapid over the past few decades, however, the detailed understanding on the the scientific and technological nitty-gritties associated with the mesoscale systems is perhaps at their initial stages. Moreover, the emerging quantum technologies require a large-scale experimentation employing a wide range of micro to nanoscale devices. Thus, extensive research activities have been observed in exploring the diverse unknown aspects of the mesoscale systems.

In particular, the research and development of the microfluidic devices have become an emerging arena, which connects various multidisciplinary fields involving physics, chemistry, bio-sciences, mathematics, computation, and engineering, in order to host the state-of-art applications. The manipulation of fluid at the sub-millimetre length scale has direct applications in reaction, pumping, transport, mixing, sensing, and drug delivery, among many others. For example, microfluidic reactors have become an integral part of every other contemporary application that include MEMS, sensors, lab or organ-on-a-chip, and artificial plant devices. The upsurge in the usage of these microscale embodiments can be attributed to several unique advantages as compared to the conventional macroscopic platforms. It is well known that the microreactor technology is limited by diffusive length and time scale because of the low Reynold number. However, digitization of multiphase flow inside a microreactor has enhanced the available

surface to volume ratio, boosting mass-momentum-heat transfer, and reactions in the regimes belonging to the sub-millimeter length scales.

Furthermore, the presence of external fields such as electric, magnetic, electromagnetic fields have enriched the applicability in the directions of chemical synthesis and reaction. In fact, the usage of a lower volume of reagent has made the technology less costly and safe with minimum possible wastage, as compared to the conventional macroscale reactors. In addition to that, the selectivity of one over many possible products can be controlled by exploiting the local conditions and the available process parameters. On the other hand, the point-of-care (POC) technologies have started flourishing with microfluidic reactors owing to its low residence time with quick reaction time scale. The continuous flow synthesis inside the microreactor has attracted many industries because of its superior conversions and yields. Further, the research related to drug delivery, anti-cancer therapeutics, tissue culture, three-dimensional (3D) cell culture, fertilization, and nano-robots has started utilizing the microreactor technology to make the efficient lab-on-a-chip device by mimicking the 3D microenvironment inside the microchannel.

In view the above context, the current thesis explores the usage of the microfluidic reactor in the direction of the efficient reaction, mixing, biomarker sensing, and transport through porous media and *in-vitro* drug delivery. The objectives of the present work as follows,

- Electric field assisted multicomponent reaction in a microfluidic reactor for superior conversion and yield.
- Microfluidic immunosensor for point-of-care-testing of beta-2-microglobulin in tear.
- Self-organized implanting of micro/nano filtration membranes in advanced flow μ-reactors.
- Drug encapsulated cellulose nanoparticle induced death kinetics of cancer cells in microfluidic channel.