Some of the research topics in which there is a vacancy (for a PhD position) at IAP are as follows:

1. **LANSPE LAB**

Research at LANSPE is based on engineering fluid flow and instabilities for scalable manufacturing of soft photonic and electronic devices over large area substrates and fabrics in an efficient yet cost effective way! In our lab we address unexplored fundamental questions of fluid dynamics and instabilities thereby proposing novel designs and devices which can be impactful for technology. To this end we rely on two methods (1) nanoimprinting and dewetting of optical glasses and polymers and (2) 3D printing technique to fabricate and design optical devices for computation.

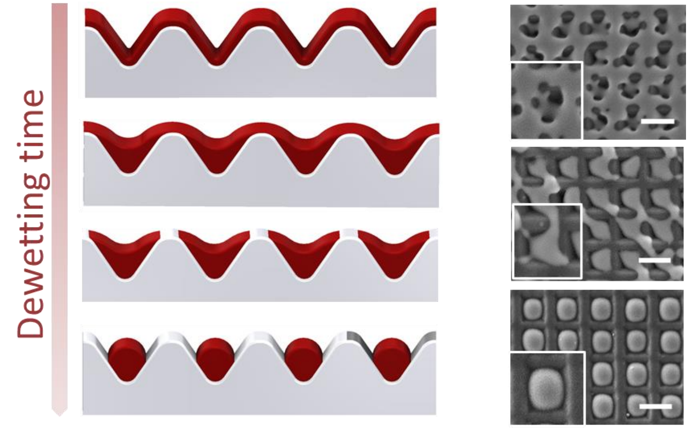

Figure: (left) (top to bottom) Schematic illustration of the dewetting process (right) Scanning Microscope Image (SEM) showing the time evolution of the film morphology [Nature Nanotech 2019]

Project details: Managing light at the nanoscale beyond the rigidity and size of silicon wafers holds significant promises for applications in light trapping structures for energy harvesting , epidermal sensors and artificial skin , flexible photonic circuits , bio-sensing and imaging or flexible optoelectronics and photovoltaic. Wafer-based lithography techniques remain the dominating tool to fabricate devices with micro- and nanoscale feature sizes. If their high resolution remains unchallenged, they are still rather complicated, expensive, and difficult to scale to large area. These techniques have been employed to fabricate flexible passive and active photonic systems by using the transfer printing of semiconducting nanomembrane technique. While high performance devices such as photodetectors, LEDs, Photonic crystals, or Fano resonance filter (based on Si, Ge, III-V semiconductors.) can be structured and then transferred onto a flexible substrate, the technique retains the limitation of lithography approaches while requiring further complicated processing. Another approach that has recently emerged relies on the monolithic integration of photonic structures directly on a flexible plastic substrate. Passive photonic devices such as optical waveguides, resonators, gratings and plasmonic nanostructures have been fabricated with this approach that typically involves the patterning via soft nano-imprinting of polymer layers or more recently chalcogenide glasses. While simpler than wafer-based techniques, this approach is limited to a particular set of materials and percolated structures, and is not well amenable to stretchable systems or the fabrication of active devices. The solutions for photonic devices that can be stretched are even more at their infancy. Stretchable waveguides require complex processes to pattern PDMS moulds, for rather poor performance. Most proposed designs are inspired by flexible electronics, where active rigid devices are integrated in a stretchable substrate with rigid serpentine-like contacts that comply with stretching loads. In this project, we propose to fabricate photonic crystal based integrated circuits on stretchable and flexible substrate for applications in optical computation. We will rely on our process of 2D or 3D printing based additive manufacturing techniques to fabricate such structures. Our devices might find applications in light beam manipulation, optical computation, energy harvesting and artificial skin in robotics. We are looking for students in various domains like electronics, photonics and physics.

2. **Optics and Microfluidics Instrumentation (OMI) Lab** at IAP-IISc: Prof. Sai Siva Gorthi's group

Latest Publications from OMI Lab: [Google Scholar]

Project Description for Prospective PhD Students: While much research efforts are being invested in point-of-care diagnostics, they are highly diffused and the resulting prototypes tend to be built on mutually incompatible platforms. Thus, whenever a variety/panel of tests are required, the only option is to use a conventional centralized laboratory, which requires significant investment and also cannot serve remote areas and other scenarios such as space missions and pan-India digital health missions.

This project aims to work towards a common platform technology which would be able to perform all four major test categories- cytology (microscopy), molecular biology, bio-chemistry and immuno- chemistry based. New architecture which support hardware, operating system and software on a single instrument to support realization of the aforementioned four classes of in-vitro diagnostic platforms is being developed in our lab. It would utilize in-built sensing and actuation methods to conduct the test on a disposable cartridge. The smart-cartridge (and an accompanying reagent pack) would be test-specific and thus, modular and upgradable. This would enable the entire community of researchers in not so directly related areas also to align their output towards upgrading a unified and highly useful system.

The system would be portable enough to be carried in backpacks and low-cost enough to be produced on a massive scale. Complete/nearly complete automation and internet connectivity would ensure high reliability, low operator training and possibility of data analysis too. Such a system could be targeted towards mass detection of virulent diseases like Malaria, Dengue; genetic abnormalities such as Sickle-Cell disease and Thalassaemia; nutritional disorders such as Diabetes & Anemia; and fatal conditions such as HIV, TB etc. Development of such a "Lab to Point-of-Need" technology would not only result in few patents and products, but have high chances of getting licensed by In-vitro diagnostic companies.

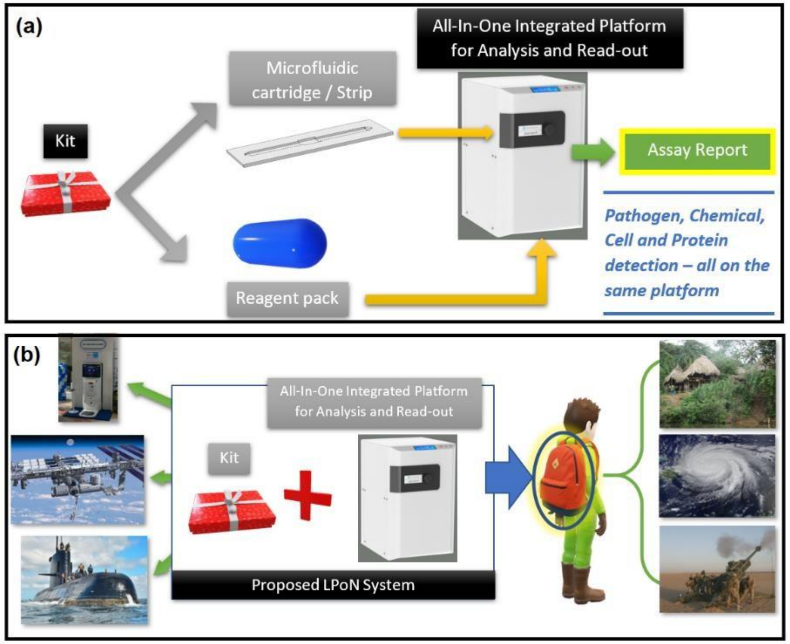

Figure: (a) The system consists of an integrated platform capable of performing all major types of assays. It would accept a pair of test-specific cartridge and reagent pack. The test would be performed automatically and the results would be relayed over internet or on an attached screen. (b) The whole system (platform plus kit) would be portable enough to carried in a backpack and used in remote areas, places affected with natural disasters or wars, constricted spaces such as submarines, space missions, ports of entries & even public health kiosks.

3. **Photoacoustic tomography** is an emerging imaging modality capable of providing optical contrast at acoustic resolution. Specifically, we can resolve molecular information like oxyhemoglobin, deoxyhemoglobin, lipids, and water. This project will aim at developing advanced computational methods for using ultrasound images to derive apriori physical information like optical maps. The derived optical maps will then be used to make photoacoustic imaging more quantitative and accurate; further the same will be compared with existing model-based approaches. Finally, these developed methods would be evaluated with phantom and ex-vivo experiments.

Representative Image (taken from E. Mercep, et. al., LSA, 8, 18 (2019)):