FABRICATION OF POLYMERIC MICROSTRUCTURES HARNESSING THIN-FILM INSTABILITIES AND ITS APPLICATION IN POINT-OF-CARE OPTICAL SENSING

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by

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Chapter 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

Two different point-of-Care device concept has been developed to utilize advantage of microfluidic environment. First three chapters are focused on developing a point-of-care testing device for the quantification of cells by imaging cell suspension in a microfluidic channel. By reducing the distance between image subject and lens pole, the numerical aperture of the lens was increased which allowed to capture the more number of diffracted patterns to be captured by the lens. As per the Abbe relation increasing the numerical aperture increases the resolution limit of the microlenses in the microfluidic setup. This advantageous condition was utilized to estimate the number of particles of size 3µm in a given suspension using by an objective of 20X/0.40. The particle density was demonstrated to be estimated with an accuracy of more than 90% using image processing (ImageJ). Microlenses were found to produce 5-10 times add on magnification, enhanced resolution and apposition images rather than superposition images as shown by previous reports. Keeping this development as basis, next two problems were identified to transfer this technology to the on field applications. In the second chapter we tried to obviate the use of standard microscope by using a lens attachment to the cellphone camera. We demonstrated that a simple thermal remoulding process of a polymer pellet turned it into a transparent lens by adjusting the free volume between polymer molecules. This lens attachment was demonstrated to increase the magnification and resolution capability of a cellphone camera (8MP, f/1.9) by 2-5 times. However, we felt difficulty in Imaging through cellphone as closely spaced subject and cellphone camera poses problem of problem illumination. Thus to utilize the cellphone flashlight as illumination source, we developed a gradient wrinkled pattern to provide diffused light of different intensity from different points of the substrate. A gradient spacing wrinkled substrate was prepared by inducing gradient stress into the viscoelastic PDMS substrate. The substrate was able to modulate the intensity of light between 20 to 100 lux of a point illumination source of 120 Lux. Finally, a microfluidic device consisting of passive micromixers was designed and fabricated to bring plasmonic nanoparticles and analyte molecules into close proximity by mixing. Device was demonstrated to provide SERS enhancement and sensitivity and limit of detection (LoD) was found to be in pM and nM range for Crystal Violet and Uric Acid, respectively which is either better or comparable with the reported values. Device showed promising opportunities to be used as an independed point-of-care testing device along with a handheld Raman Spectrophotometer.

6.2 FUTURE SCOPE

The research reported in this thesis extensively covers various aspects of imaging using microlenses in the microfluidic environment. Different self-organization behaviours of polymer structures were utilized to image 10 to 50 micrometer size object using cellphone. The SERS based microfluidic device was designed and developed for the detection of biomarker. Taking the research further would require the following aspects to be considered: -

- Develop better imaging Protocols and Image processing techniques to acquire better images and more information from the acquired images.
- Using the microlenses for the multimodal Imaging and tomography applications to diagnose skin diseases.

- Developed theoretical model for wrinkling and dewetting phenomena.
- Develop Standard protocol for SERS detection in the continuous flow microfluidic channel, and device mechanism to reduce noice to signal ratio by signal processing techniques.
- Analyzing the effect of complex detection matrix of biomarkers and device routes to enhance the selectivity and application in on-field setup.