Laboratory Medicine in the Era of Disruptive Technology
LMCE 2017 & KSLM 58th Annual Meeting
October 18-20, 2017
Grand Walkerhill Seoul, Korea
www.lmce-kslm.org

Highly sensitive *In Vitro* diagnostics using optical nanosensor: Current status and future

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The development of surface-enhanced Raman scattering (SERS)-based microfluidic platforms has attracted significant recent attention in the biological sciences. SERS is a highly sensitive detection modality, with microfluidic platforms providing many advantages over microscale methods, including high analytical throughput, facile automation and reduced sample requirements. Accordingly, the integration of SERS with microfluidic platforms offers significant utility in chemical and biological experimentation. In this presentation, we report a fully integrated SERS-based microdroplet platform for the automatic immunoassay of specific target antigens. Specifically, highly efficient and rapid immunoreactions are achieved through sequential droplet generation, transport and merging, whilst wash-free immunodetection is realized through droplet-splitting. Such integration affords a novel multifunctional platform capable of performing complex multi-step immunoassays in nL-volume droplets. This assay system has additional advantages including reduced sample consumption (less than 100 μL), rapid assay times (less than 10 minutes) and fully automated fluid control. In addition, a SERS-based lateral flow assay platform will be also introduced. Lateral flow assay (LFA) strip is a simple device intended to detect the presence of a target biomarker in clinical fluids. The benefits of LFA strip include a short time to obtain test result, a user-friendly format, low cost, and long-term stability. However, it has major limitations in terms of quantitative analysis and detection sensitivity. To resolve these problems, many different optical systems including fluorescence, chemi-luminescence and electrochemical readers have been employed but they still suffer from poor sensitivity and low precision. Our research group recently developed a novel SERS-based lateral flow assay platform for the highly sensitive biomarker detection. We believe that our proposed assay platform shows a significant improvement in the limit of detection (LOD) and multiplex detection capability for important clinical biomarkers. We anticipate that this integrated SERS-based assay platforms provide new insights in the development of facile assay platforms.