Development of nano/micro- structured plasmonic chip for single cell array application

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Intensive studies on single cell monitoring and the proteins they secrete can provide important information, including early detection of infectious diseases in the human body. Traditional analytical methods only measure the average response from a highly heterogeneous population of cells. This type of measurement obscures individual cells' responses to certain types of stimuli. Studies have shown that localized surface plasmon resonance (LSPR) has risen as a promising platform for label-free and real time observation of secreted protein binding with metallic nano-structure. By utilizing its highly sensitive change in local refractive index due to successful protein binding, LSPR can also be integrated with microfluidics for continuous cell observation.

On the other hand, studies show that microwell arrays have become a new versatile platform for high-throughput cell secretion and continuous long-term cell monitoring field. Using these arrays, thousands of individual cells can be trapped within confined areas by simple gravitational sedimentation. Inspired by these reports, combining micro-structured microwell arrays with plasmonic sensing ability can provide a rapid and hassle free option for long term single cell monitoring. Using this technique, targeted cells can be isolated, trapped and analyzed using a single chip.

A clean polished Aluminum oxide electrode modified using a two-step anodizing method. The modified electrode was then coated with Su8 3010. Specific design mask was further sandwiched with Su8 layer before exposure with UV light. The exposed electrode was then developed with Su8 developer for 6 minutes. This process introduced a specific Su8 disk with a diameter of 60 μm on top of the anodized aluminum oxide (AAO) electrode. The prepared AAO was used as a hard mold to emboss 188μm thickness Zf-14 Cyclo Olefin Polymers (COP) with 400N/cm^2 force at 160°C for 10 minutes. Later, the COP film was debossed carefully from the mold before being sputtered with gold layer (Au). Field emission scanning electron microscopy shows mushroom look-alike nano structures with diameters of 200nm and micro-structured microwells with diameters of 70 μm was observed.

The sensitivity of the resultant plasmonic device was further evaluated over various surrounding refractive index environments, including air (n=1.0), water (n=1.33), 1M glucose (n=1.35), ethylene glycol (n=1.43) and glycerol (n=1.47). Our plasmonic device shows red-shifted behaviour as the surrounding refractive index value increases. The sensitivity of this shift was 116nm/RIU. New effort is taken to change parameter used and sensing material to obtain higher sensitivity in future. Further progress on the sensing device will be present.