Thin Film Centre

Thin-film technologies for biomedical devices *Shigeng Song and colleagues*

Haemocompatible DLC thin films for heart valves

Shigeng Song, Frank Placido

A joint research with:
Prof. Nan Huang,
the College of Materials Science,
Southwest Jiaotong University, Chengdu, China

Heart valve rings: right image is the uncoated titanium alloy, left is DLC coated

For medical implants, DLC coatings have the added potential to decrease platelet activation, increase fibrogin/albumin ratios and increase haemocompatibility. However, further research is necessary for critical coatings on, for example, metal heart valves and hip joints, as current DLC coating processes have difficulties in producing the required pinhole-free, conformal coatings due to the buildup of compressive stress. As the coating thickness is increased beyond one or two microns this stress tends to result in delamination of the film.

In the Thin Film Centre (TFC), we have been involved in developing a novel hollow-cathode PECVD process giving a multi-layered nanostructured DLC that has proved to be capable of producing excellent low stress and pinhole-free films with thicknesses of up to 75 microns on the inside of pipes, through gradient layer design, doping element control and process optimization. We are now investigating the potential applications in demanding medical implants. Metal heart valve rings and metal. Some preliminary trials in TFC have given ground for optimism.

Hip joint test pieces: right image is uncoated Ti alloy, left is DLC coated

Surface-enhanced Raman Spectroscopy

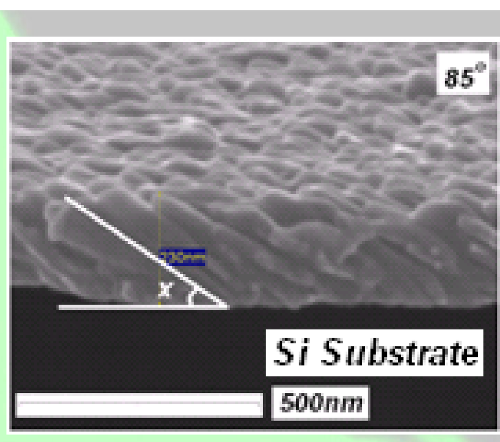
Frank Placido, Shigeng Song

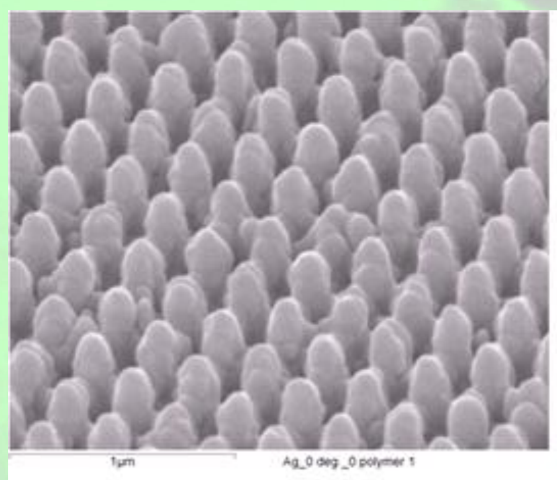
A joint research with:
Dr. Yu Chen
Photophysics Group, Department of Physics, SUPA, University of Strathclyde

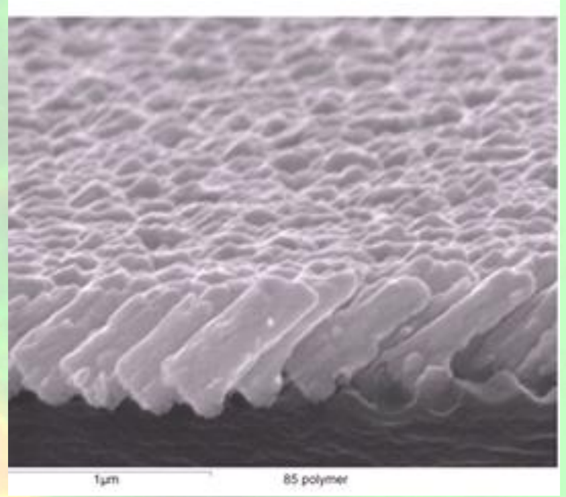
Noble metals with nanostructures have attracted tremendous attention in the past several decades due to their unique optical properties and subsequent applications, for example, surface enhanced Raman scattering (SERS). Various methods have been employed to produce nanostructured noble metal arrays. However, these methods have various issues in expense, efficiency, reproducibility, or production of a batch of large size samples.

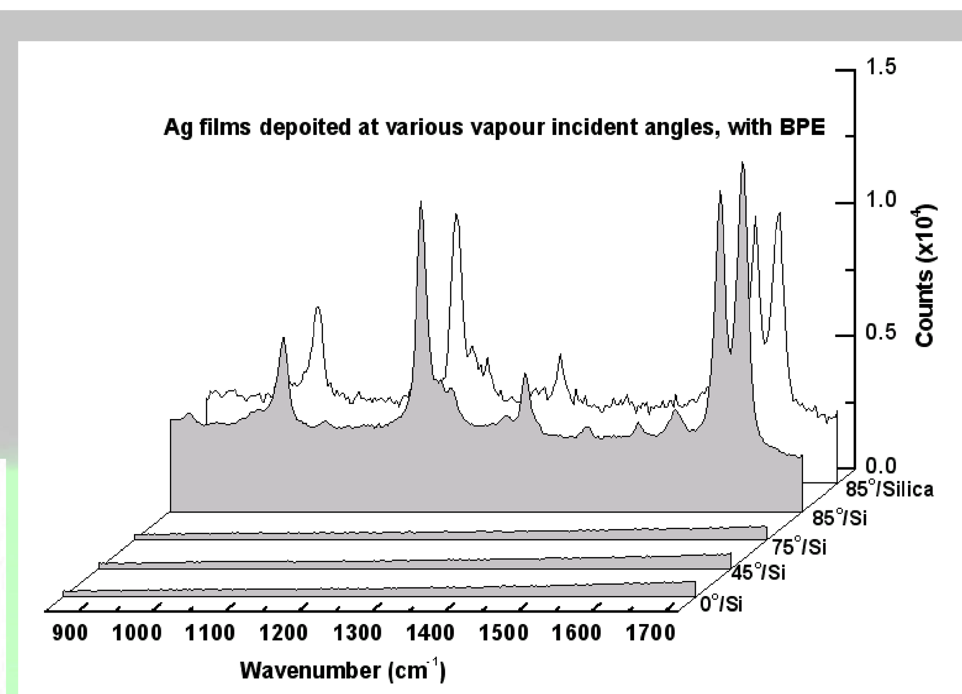
Recent results have shown that highly sensitive and stable SERS substrates can be obtained by using an oblique angle vapor deposition OAD. Also, the OAD method is suitable for producing a batch of large size SERS substrates. A wide range of columnar forms of thin film (sculptured films) can be obtained by using OAD: two dimensions ranging from simple slanted columns and chevrons to more complex C- and S-shaped morphologies and three dimensions such as simple helixes and superhelixes. High structure variation of sculptured films allows us to optimize morphology and structure to obtain better SERS substrates.

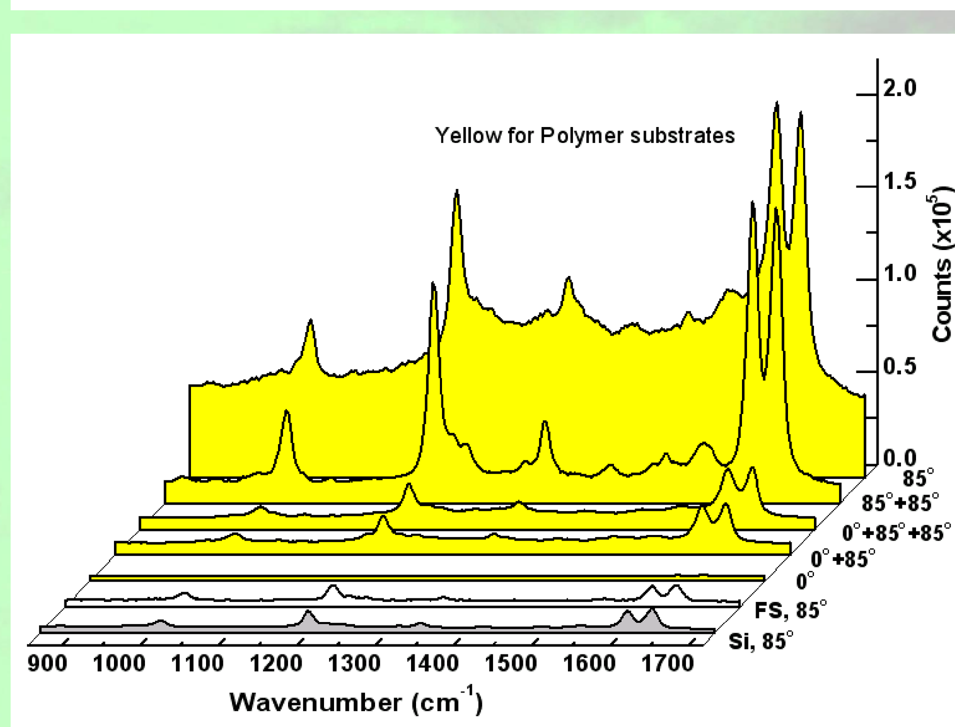
Estimated Average Enhancement Factor (AEF): >10^7 on Si, >10^8 on polymer substrate







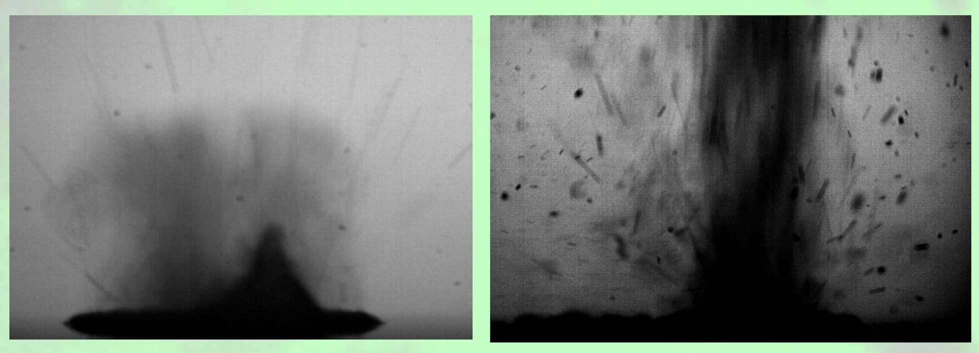




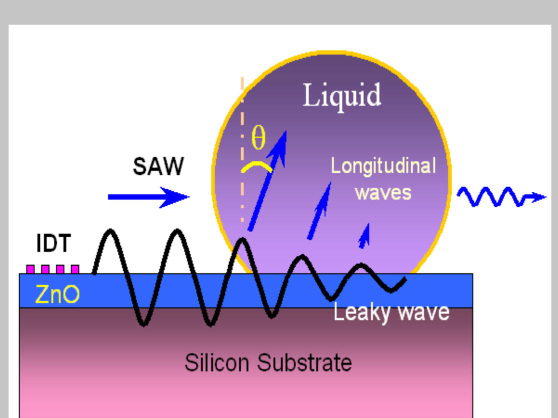
Biosensing, microfluidic and lab-on-chip based on thin film electroacoustics

Richard Fu, Chao Zhao, Gordon Guo, Ahmed El-Hady, Frank Placido

In collaboration with Edinburgh, Glasgow and Cambridge Universities, we have demonstrated that thin film based surface acoustic wave (SW) devices are promising for biosensing, microfluidics, cell biology and lab-on-chip applications.

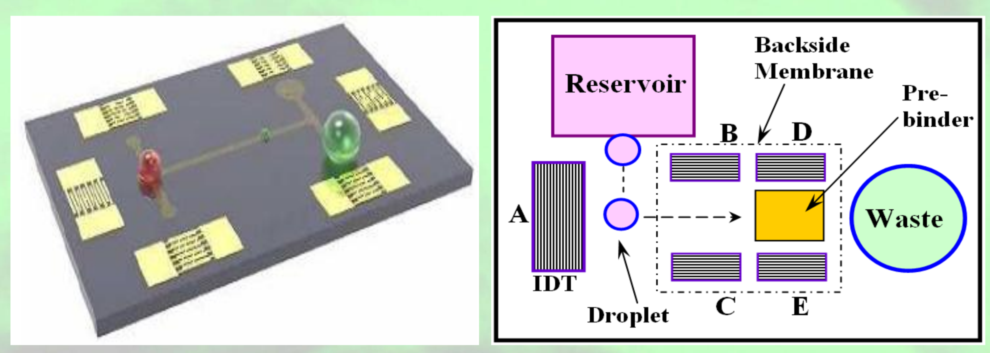


Thin Film Nebulisation of liquid



SAW/liquid interaction

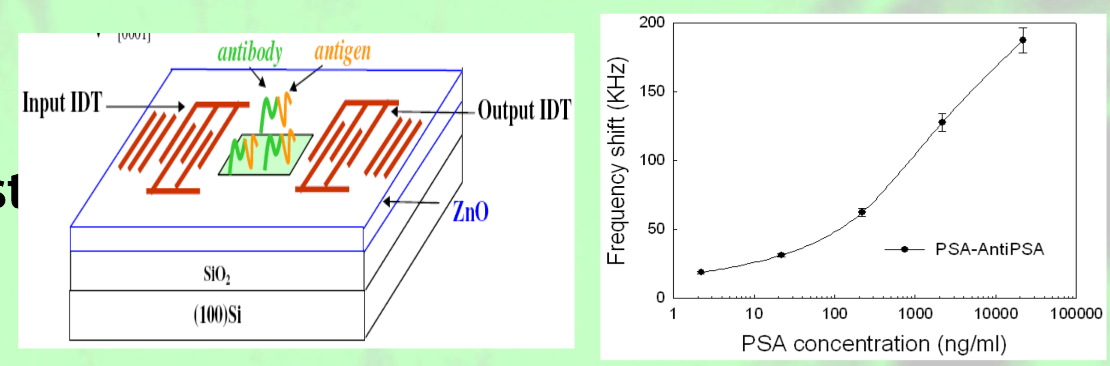
Cell/particle streaming, mixing, concentration



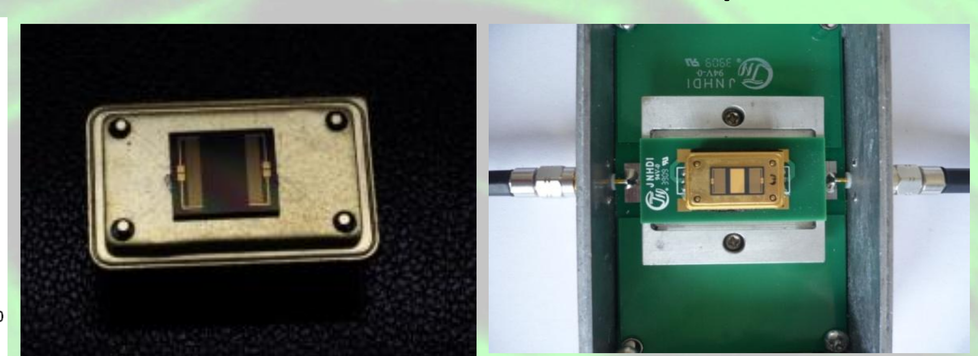
Acoustic wave based lab-on-chip

Our main research work include:

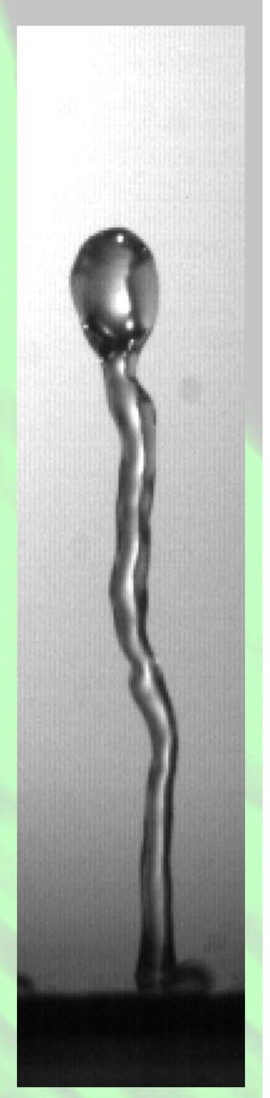
- Thin film acoustic wave microfluidics
- Cell manipulcation, cell lysis, and PCR using acoust waves
- Acoustic wave based biosensing
- Lab-on-chip and integration of microelectronics, microfluidics, cell biology and biodetection



Acoustic wave based biosensing



Designed thin film SAW devices



Acoustic wave jetting

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