Report on UK Fluids Network Short Research Visit 'Experimental investigation of droplet impact on inclined surfaces in presence of surface acoustic wave (SAW)'

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During this short research visit, using the high-speed camera setup, the process of droplet impact on hydrophobic surface of the SAW device was captured. The process of the experiments and the results analysis process are explained below. To obtain a hydrophobic surface, the surface of the SAW device was coated with a hydrophobic CYTOP (Asahi Glass Co.) layer. To measure the resonant frequency and the amplitude of the SAW device, an HP8752A RF network analyser was used. The generated Rayleigh wave by RF signal generator (Marconi 2024, Plainview, USA) was amplified using an RF power amplifier (Amplifier research, 75A250, Souderton, USA) before applying to the IDTs.

Droplets of deionised water, with a density of $\rho = 995\ kgm^{-3}$ and surface tension $\gamma = 72 \times 10^{-3}\ Nm^{-1}$ at 21 °C with volumes between 3.5 and 5.8 µl were generated by squeezing the nozzle until the droplet is detached under gravity from the edge of a needle (BD Microlance). By adjusting the drop height, the impact velocity was varied between 1.4 and 2 m/s. The impact process was filmed from side-view using a high-speed Camera (HotShot 1280CC) at 5000 fps. Contact time of the droplet was defined for all the cases between the first touch of the droplet south pole to the surface and when the last subunit of the water is separated from the substrate. The SAW was applied just before the droplet detachment from the needle to skip the temperature raise in the solid surface. To investigate the droplet impact on inclined surfaces in presence of SAW, the effect of droplet volume, inclination angle, applied SAW power and SAW device frequency on impingement dynamics were investigated during the experiments. For instance, Snapshots of droplet impact on a 30 degree inclined surface is presented in Figure 1.

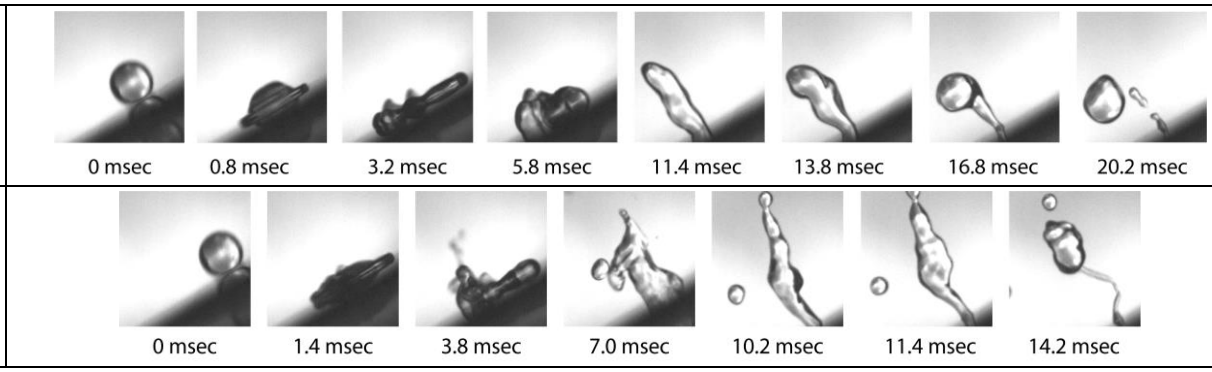

Figure 1: Droplet impact on a SAW device with inclination angle of 30 degree. The applied power is (a) 5 w (b) 15 w. For this experiment SAW travels upward.

Title: Zinc oxide (ZnO) thin film deposition and characterisation

Another part of the research visit was deposition of thin films of ZnO (~5nm) on different substrates by PVD method. As shown in Figure 2, to enhance high quality films on the substrates, a DC reactive magnetron sputtering system (Nordiko) was used. Two rectangular zinc targets of 99.99% purity were used for deposition. Aluminium plates with different thickness, aluminium foils and silicone disks were used as substrates for the deposition. All the substrates were cut into pieces of 10 × 10 cm and was fixed inside the chamber by Kapton tapes as shown in Figure 3.

Figure 2: Nordiko sputtering machine

Before installing all the substrates inside the chamber, the surface of the substrates were cleaned in four steps consisting cleaning with acetone followed by ethanol, and then rinsing with deionised (DI) water and drying with nitrogen.

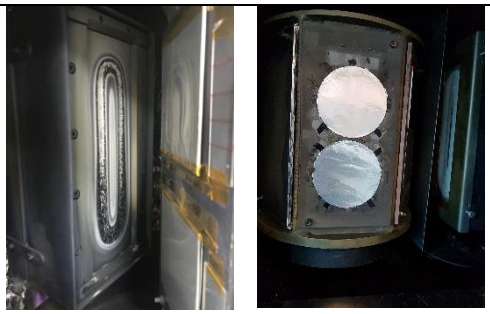

Figure 3: aluminium foil and Si substrates fixed on the holders and they are ready for ZnO deposition by 99.99% Zn targets

A large hexagonal cylinder-type holder is installed inside the chamber of the Nordiko system. All the samples are taped on six 40 × 20 cm rectangular plates and then all the plates are fixed on the holder with screws at a distance of 20.0 cm from the targets. The holder was rotated at a speed of 4.0 rpm during the deposition. A few glass slide samples were also installed on the holder for deposition thickness measurement purposes.

After installing all the samples inside the chamber and closing the chamber door, a high pressure vacuum pump was used to reduce the chamber pressure ~2.5×10^{-3} mbar and then a high vacuum pump was used to reduce the chamber pressure to 5×10^{-6} mbar. Argon and oxygen gases were injected into the chamber with flow rates of 22 and 6 sccm (standard cubic centimetre per minute), respectively. The deposition process started by applying 400 watts power (380 V and 1.05 A) to both Zn targets.

After closing the chamber door, the vacuum pump was turned on, and a chamber pressure of ~3.75 mTorr was maintained during the deposition process. A pre-deposition cleaning process was performed for five minutes by applying a radio frequency (RF) power of 200 watts, a reverse power of zero watts. The argon (Ar) gas flow rate was ten sccm. There was no intentional heating of the substrate, and the maximum monitored temperature throughout the deposition process reached 55 ^{o}C. A deposition thickness of 5.5 µm was obtained after 16 hours of deposition. A sample of Al film deposited with ZnO is shown in figure 4.

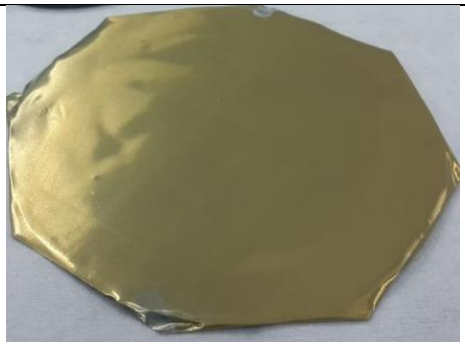

Figure 4: ZnO deposited on Al film

ZnO thin film was characterised using a scanning electron microscope (SEM) for surface morphology and cross-section. The film structure, orientation and crystallinity were characterised using X-ray diffraction (XRD) analysis. The surface roughness of the deposited ZnO thin film on aluminium foil was characterised using an atomic force microscope (AFM).