Highly monodisperse droplets are attracting great attention both in many research areas, such as aerosol science, combustion, and Nano-manufacturing. This thesis invents a novel aerosol generator: "Periodic Electro Hydro-dynamic Chopper" termed as "PEHD chopper", and develops a new method to directly print micro-patterns with monodisperse droplets.

The principle of the PEHD chopper is to use the fringe electric field of a capacitor to introduce controlled perturbation on a liquid jet.

We first derived the governing equations for a circular inviscid liquid jet under transverse electric fields. The electric fields were obtained through numerical simulation. Then we used a high speed camera (up to one million frames per second) to visualize the jet break-up as well as the droplets' size and shape.

The experiments show that the PEHD chopper can effectively "chop" a neutral micro-jet and generate highly monodisperse micro-droplets, which diameter range from 100 µm to 500 µm. To reduce the droplet size, PEHD chopper with a butterfly design is applied on a typical single electrospray. In this configuration, the jet swings at long wavelengths (λ>λR), where λR is the Rayleigh wave length, but breaks up into highly monodisperse droplets near 2λR and λR without satellite droplets. The butterfly configuration combined with electrified jet expands the diameter range into 20 µm to 100 µm.

Finally, we demonstrate the electrospray printing of Polymer Derived Ceramics (PDC) for sensor applications in harsh environment. A modified single ES with an additional driving electric field is used to directly print PDC precursor without mask, we achieved 1D feature as narrow as 35 µm and a micro pentagram pattern. Moreover, after pyrolysis of PDC at 1100 °C in nitrogen, amorphous alloys of silicon, carbon and nitrogen (SiCN) are obtained. The samples exhibit excellent good integrity and adhesion to the substrate.