Summary

The flexible electronics market is evolving dynamically, attracting growing interest from researchers and industry alike. One of the main areas of research in this field explores innovative rapid prototyping methods that help fill the resolution gap between traditional manufacturing techniques. This study centres on the relatively novel technology of Aerosol Jet Printing (AJP), which demonstrates significant potential for applications in flexible electronics.

A critical aspect of the work involved designing a prototype AJP device, which required detailed preliminary investigations of system components. Based on an extensive literature review, theoretical foundations for this technology were developed, and key research areas were identified. Experimental studies utilized three commercially available nanoparticle-based silver inks, with initial efforts focusing on testing aerosol generators. Droplet size measurements were performed using graphical algorithms analysing droplets deposited on polymer substrates. Over 80,000 data points were collected and statistically analysed, resulting in detailed box plots with outliers. This visualization approach enabled precise comparisons of ink properties and droplet parameters critical for optimizing the AJP process.

The next stage involved the design and fabrication of test nozzles to analyse geometries that generate the aerodynamic lens effect. The nozzles were designed in a CAD 3D environment and fabricated using SLA printing technology. Further research focused on optimizing the working and sheath gas pressure parameters to determine the aerosol stream's focus factor.

Tests were also conducted on three sintering methods for the inks, including the effects of a heated process table. For ink 6n, detailed morphological analyses were carried out using a scanning electron microscope (SEM) and a confocal microscope. Additionally, the use of a syringe pump enabled testing with a larger volume of ink, leading to the determination of an optimal sintering procedure for each ink. The resulting samples were used to evaluate the impact of conductive track width on resistance and conductivity, considering various sintering methods such as furnace sintering and NIR lamp sintering.

The final step involved analysing the durability of conductive pathways to atmospheric conditions and investigating their mechanical properties using nanoindentation.