Visualising Substrate Adhesion to Microneedle Arrays

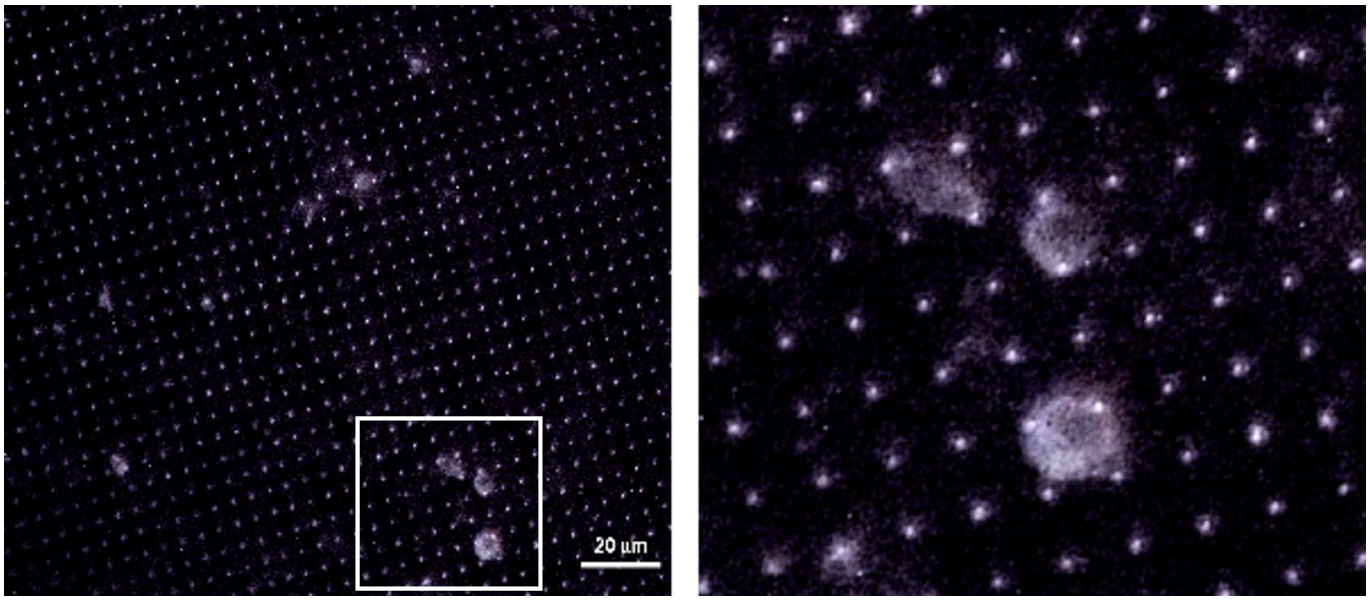
The commercial value of microneedles lies in their transformative potential across multiple high-value industries, especially pharmaceuticals, vaccination, cosmetics, and biomedical diagnostics. These tiny devices—typically ranging from tens to hundreds of microns in length—offer minimally invasive, highly targeted, and often pain-free delivery of active substances through the skin.

Microscopy plays a critical role in the commercial development and quality assurance of microneedles, which are miniature needle structures used in medical and cosmetic applications. These needles typically range from tens to hundreds of micrometres in length, making microscopy essential for examining their form, function, and integrity.

Conventional microscopy methods—like brightfield, epifluorescence, and standard widefield imaging—are often used for analysing microneedles, but they come with significant limitations when precision, depth, or surface characterisation is critical.

HaloMicroscopy enables clear distinction between the silicon substrate and biological material, leveraging optical scattering properties. The technique reveals subtle topographic cues and surface interactions that are often missed with conventional brightfield imaging.

Cellular adhesion on a silicon microneedle array



An array of silicon microneedles (200nm diameter), on a silicon wafer showing the adhesion of biological material. This image was taken in ambient conditions, with no sample preparation. The zoomed-in region on the right reveals membrane contours and points of adhesion between the cells and the microneedle structures. Distortion of the cellular membrane is evidence of the strong binding of the substrate to the needles. (Scale bar = 20 µm)

Regulatory bodies like the FDA or EMA require comprehensive physical and mechanical characterisation. High-resolution imaging is often mandated in technical documentation to prove reliability and safety. HaloMicroscopy can provide a rapid and reliable solution to assist in QA and QC for the development and production of micro-needle arrays. It also provides valuable insights into the mechanics of the binding of biological materials such as vaccines used in drug delivery systems.