Microscopic topography of ultrasound probes: implications for high-level disinfection and infection control

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INTRODUCTION

Ultrasound probes vary in design, often containing grooves, notches, guide features, orientation markers, seams, detachable components, and connector ports. Routine clinical use can also contribute to surface wear.

These structural complexities can create areas that may be difficult for certain disinfection modalities to reach, increasing the possibility that microorganisms are shielded from microbial eradication.[1-5]

This descriptive study evaluated the microscopic topography of endocavity and surface ultrasound probes using scanning electron microscopy (SEM) to assess their potential to harbour microorganisms of varying size.

METHODS

This study does not compare, evaluate or recommend specific high-level disinfection modalities or products.

Probes assessed:
- 4 Endocavity probes
- 1 surface probe

Probe selection criteria:
- Previously in routine clinical use*

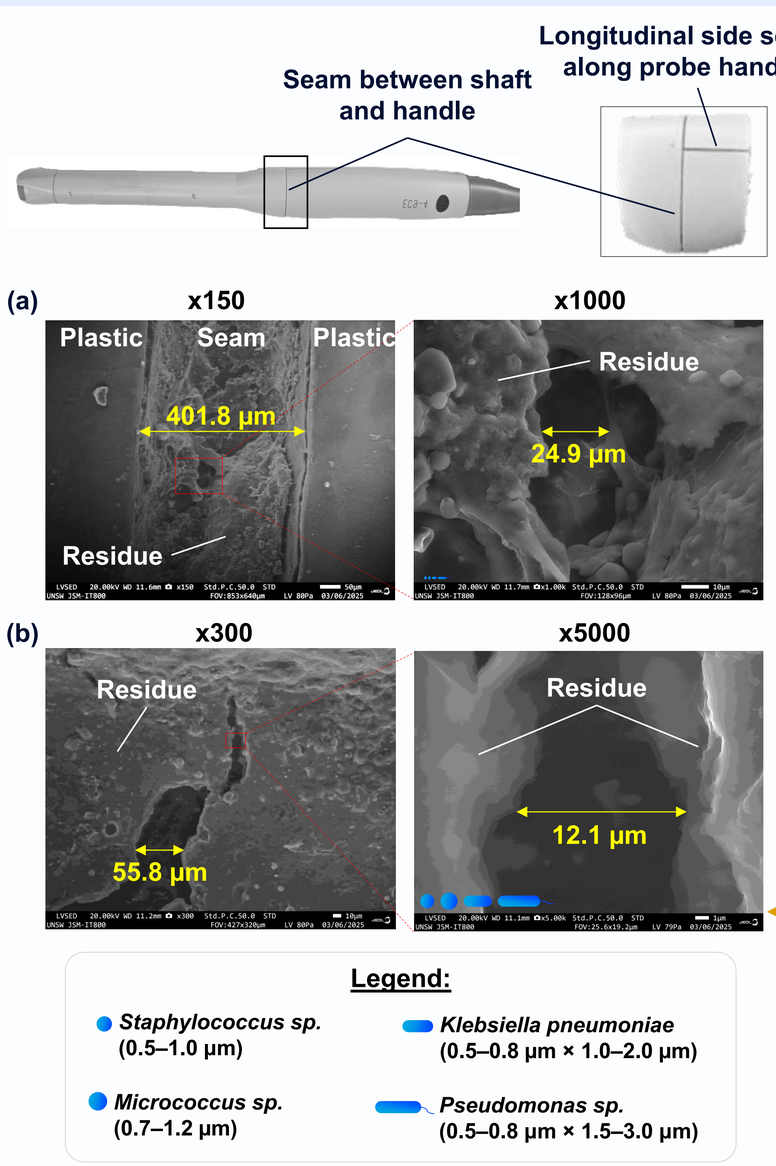
*Selected probes had been decommissioned for reasons unrelated to the study.

- Probes were **cut into segments.**
- Segments represented **varied surface materials** and **design features**

- **46 sites** over **15 probe segments** were imaged using SEM without **conductive coating.**
- **Widths** of seams, crevices, and gaps were **estimated using the scale bar** in each SEM image.

RESULTS

Figure 1. Representative SEM images of (a) the seam between the shaft and handle and (b) a longitudinal side seam along the probe handle of an endocavity probe, shown at increasing magnifications*



32 sites contained measurable gaps, crevices, or seam widths, with estimated widths ranging from 0.9 µm to 480.4 µm.

Rough texture on lens surfaces

Lens surfaces exhibited a microscopically rough texture, with crevices observed at higher magnification.

Scratches contained crevices

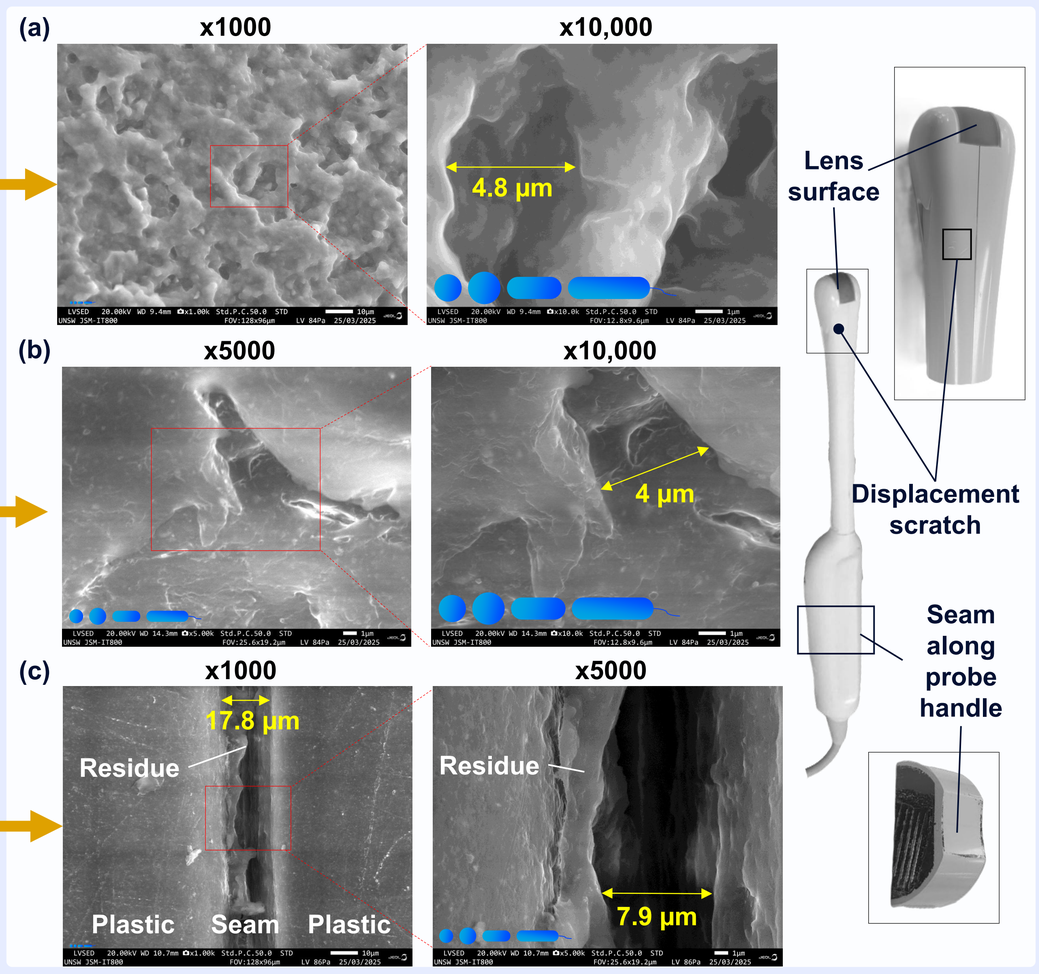
Surface wear such as this displacement scratch had measurable crevices.

Seams contained residue

Probe seams unexpectedly appeared to contain dried residue. Gaps were observed within this residue at higher magnification.

The residue even appeared to encrust a seam edge

Figure 2. Representative SEM images of (a) the lens surface, (b) a displacement scratch and (c) the seam along the handle of an endocavity probe, shown at increasing magnifications*



These observed gaps, crevices and seams are wide enough to harbour clinically relevant microorganisms such as *Staphylococcus sp.*, *Micrococcus sp.*, *Klebsiella pneumoniae*, and *Pseudomonas sp.*[6–13]

*Red boxes indicate the regions selected for higher magnification, with the corresponding magnified views to its right. Yellow lines indicate widths of seams and gaps. The measurements presented are illustrative and not representative. Scaled representation of bacteria at the bottom illustrate their potential to fit within probe microscopic topography. Name, shape, and size range of the bacterial species is provided in the legend.

CONCLUSIONS

This SEM analysis demonstrates the microscopic surface topographical complexity of ultrasound probes, and the potential for microorganisms to be shielded within these features. These findings underscore the relevance of probe surface microtopography as a consideration for future device processing research. Future studies are needed to evaluate cleaning adequacy and disinfection efficacy across these complex probe surface topography, as these outcomes were not examined in this present study.

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Conflicts of interest: RM, JF, and LJ are employees of Nanosonics Ltd. MJA provides consulting services for Olympus America, Nanosonics, and Healthmark; and serves as a sponsored educational speaker for Olympus, 3M, and Nanosonics. AP and TK have no conflicts of interest. AP is an employee of Nelson Laboratories. TK is an employee of Johnson & Johnson. JB is an employee of and holds shares in Nanosonics Ltd.

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