■Express reports

Influence of Hydrogen Peroxide Sterilisation on Plastic Surface

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Summary

Background: In the results of previous studies, various problems were revealed, such as problems of hydrogen peroxide (HP) exposure from HP gas sterilisation equipment to the surrounding environment [1,2], of residual or deterioration of HP on medical equipment parts or of their material after sterilisation [2,3], of the precision of the chemical indicator (CI) [4], and of residual hydrogen peroxide on plastic materials after sterilisation [5]. In addition changes of plastic surface structures are suspected.

Objective: This study examines plastic material surfaces after hydrogen peroxide sterilisations.

Methods: The influence of hydrogen peroxide sterilisation on the surfaces of plastic materials (eleven plastic panels) was evaluated by scanning electron microscope.

Conclusion: HP sterilisation induced the structure changes of the plastic materials. However, the cause has not been clarified yet, still further study is required to draw a definite conclusion.

Key words：Hydrogen Peroxide; Steriliser; Plastic Materials

Introduction

Hydrogen peroxide (HP) sterilisation is generally considered to be clinically effective and safe as a germicidal procedure, as it is decomposed to oxygen and water easily.

However, the results of the series of experimental study using electro- chemical detector (Polytron 7000®, Draegel) in our previous studies (Yoshida & Kobayashi 2012), revealed that some plastic materials keep higher residual hydrogen peroxide after sterilisation by the two types of low-temperature hydrogen peroxide gas plasma steriliser (LHPGPS) (STERRAD® NX™, Johnson & Johnson) and low-temperature hydrogen peroxide vapour sterilizer (LHPVS) (AMSCO® V-PRO® maX, STERIS) [1-5]. So personnel engaged in the sterilisation have possibility to be exposed to the dangerous concentration of hydrogen peroxide vapour in the air.

This current study examines the situation of the plastic surface after hydrogen peroxide sterilisation by scanning electron microscope.

Methods

The influence of hydrogen peroxide sterilisation on the surfaces of plastic materials was evaluated by scanning electron microscope (SEM).

The plastic materials were eleven kinds of 10mm×10mm×6mm panels: polyetherimide (PEI), polyethylene (PE), polytetrafluoroethylene (PTFE), nylon6 (PA6), nylon 66(PA66), polyethylene terephthalate (PET), polyetheretherketone (PEEK), thermoplastic polyurethane (TPU), polymethylmethacrylate (PMMA), polypropylene (PP), and polycarbonate (PC). And stapler handle made PA6 reinforced with fiber glass and includes titanium as white pigment (unpublished data) were also observed.

They are sterilised by two different hydrogen peroxide (HP) sterilisers, LHPGPS and LHPVS. The surfaces of plastic panels were viewed in an environmental scanning electron microscope (JSM-6380LA, Japan Electron Optics Laboratory Ltd.) using the secondary electron imaging (SEI) mode at a working distance of 10 mm and an accelerating voltage

of 5kV.

Results

The results of the SEI are shown in Figures 1 to 4. On the surfaces of PA6 after the two types of sterilisations crack and crackle are occurred as shown Figure 1-2 to 1-4 after the sterilisations. The surfaces of PE became lumpy and rugged also after the sterilisations as illustrated in Figure 2-2 to 2-5. On the surfaces of PP, many scattered seed-like changes as were observed as in Figure3-3 and 3-4. On the surfaces of other plastic panels, no apparent changes were observed after the sterilisations.

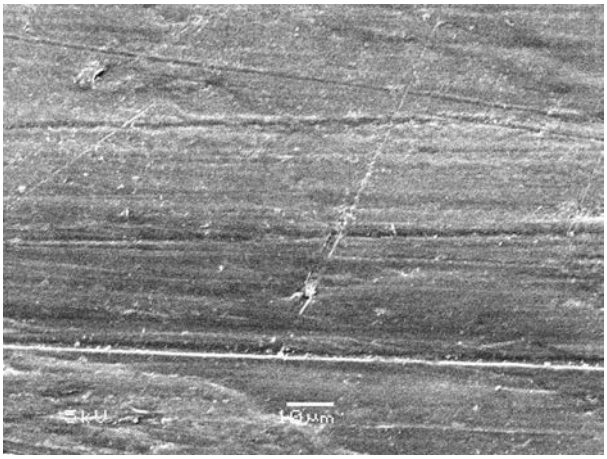

Figure 1-1. secondary electron imaging (SEI) of PA6 panel-surface before sterilisation (×1000)

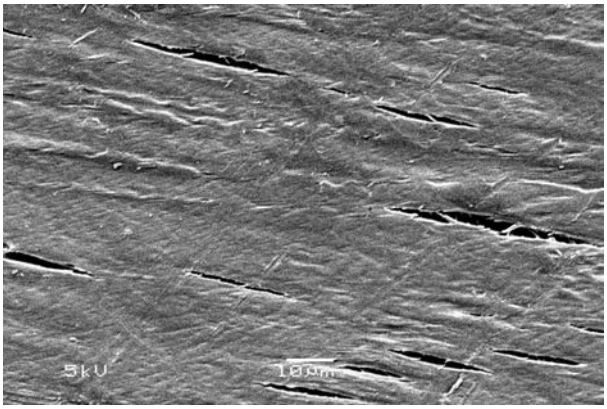

Figure 1-2. SEI of PA6 panel-surface PA6 after once of sterilisation by LHPGPS (×1000)

Crack and crackle on the surface.

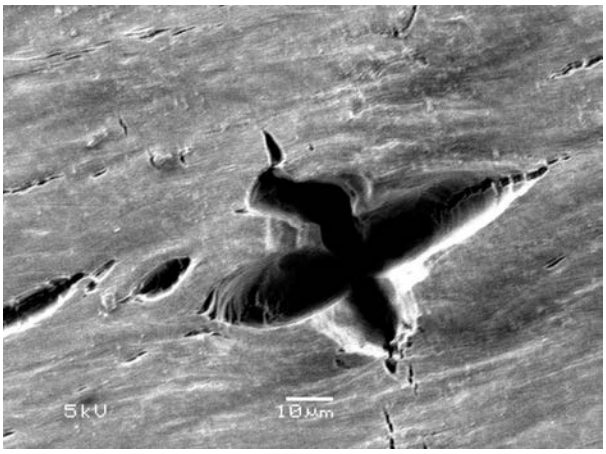

Figure 1-3. SEI of PA6 panel-surface PA6 after five repeated procedures of sterilisation by LHPGPS (×1000)

A large crack in the centere.

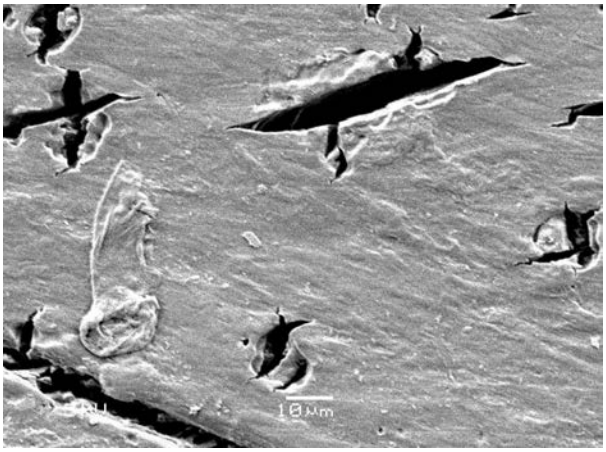

Figure1-4. SEI of PA6 panel-surface after once of sterilisation by LHPVS (×1000)

Same crack and crackle as after LHPGPS.

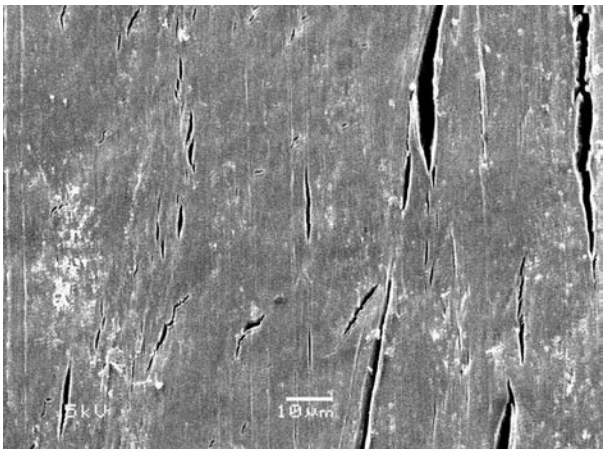

Figure1-5. SEI of PA6 panel-surface after five repeated procedures of sterilisation by LHPVS (×1000)

Same crack and crackle as after LHPGPS.

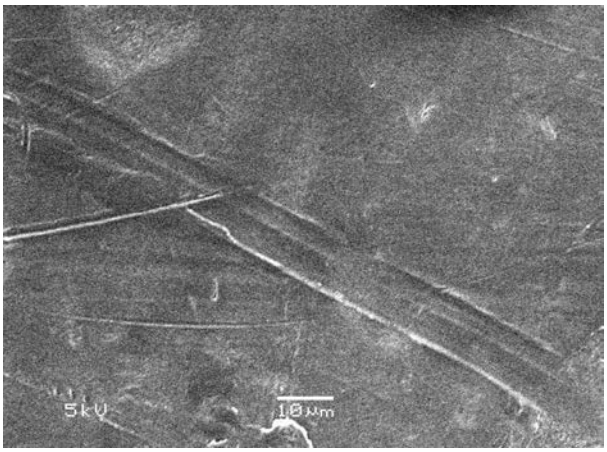

Figure2-1. SEI of PE panel-surface before sterilisation (×1000)

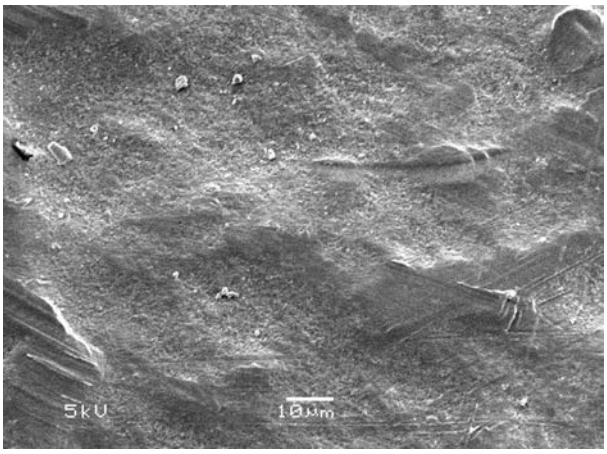

Figure2-2. SEI of PE panel-surface after once of sterilisation by LHPGPS (×1000)

Lumpy surface.

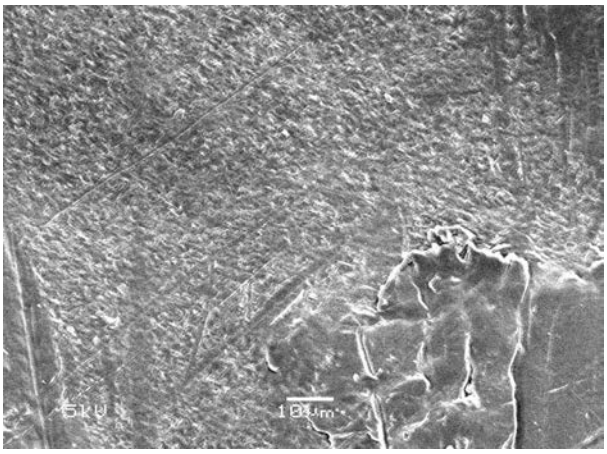

Figure2-3. SEI of PE panel-surface after five repeated procedures of sterilisation by LHPGPS (×1000)

Rugged surface.

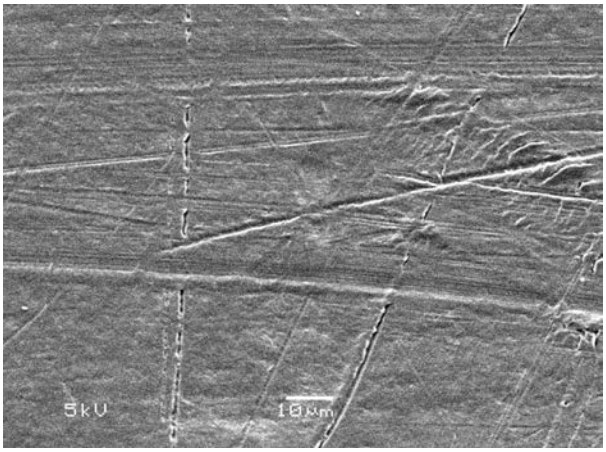

Figure2-4. SEI of PE panel-surface after oinces of sterilisation by LHPVS (×1000)

Uneven surface.

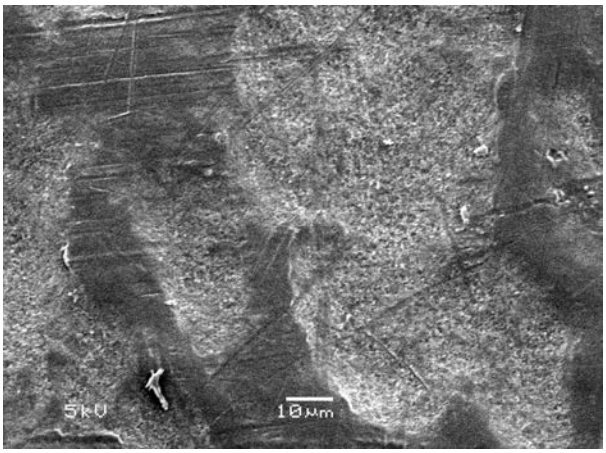

Figure2-5. SEI of PE panel-surface after five repeated procedures of sterilisation by LHPVS (×1000)

Bumpy surface.

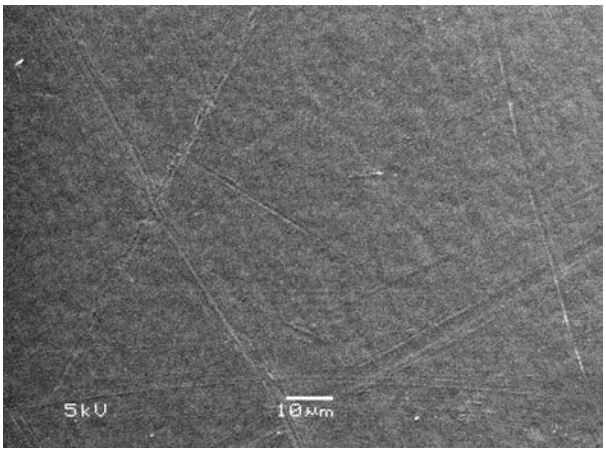

Figure3-1. SEI of PP panel-surface before sterilisation (×1000)

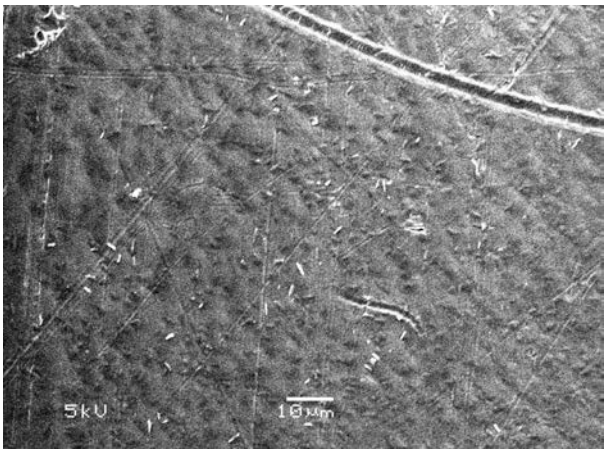

Figure3-2. SEI of PP panel-surface after five procedures of sterilisation by LHPGPS (×1000)

Many scattered seed-like changes.

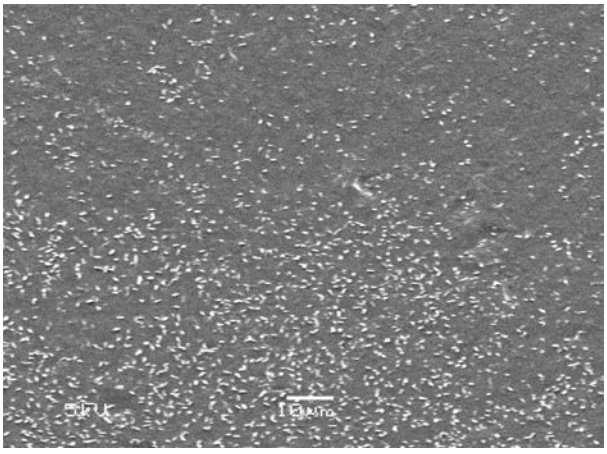

Figure3-3. SEI of PP panel-surface after five procedures of sterilisation by LHPVS (×1000)

More scattered seed-like changes than in Figure 3-2.

In SEI of stapler handle, cracks are demonstrated on the surfaces after sterilisations as shown in Figure 4-2 and 4-3. .

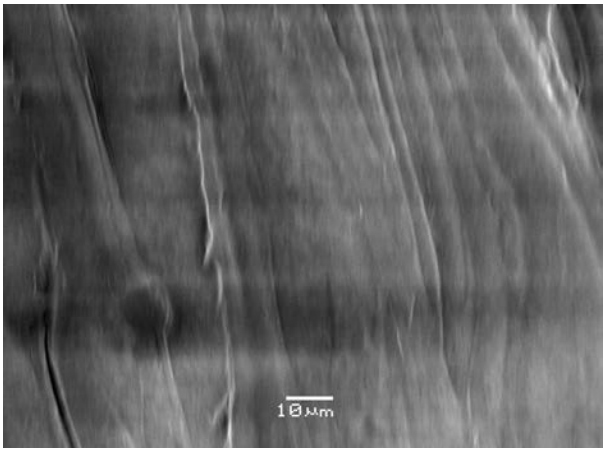

Figure4-1. SEI of Stapler (PA6) handle-surface before sterilisation (×1000)

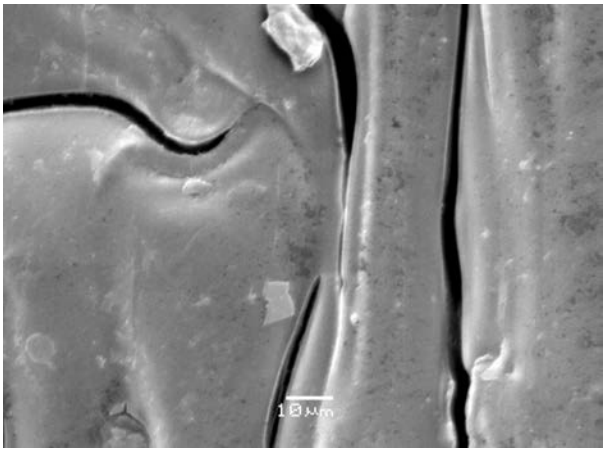

Figure4-2. SEI of Stapler (PA6) handle-surface after five procedures of sterilisation by LHPGPS (×1000)

Cracks are observed on the surface of stapler handle.

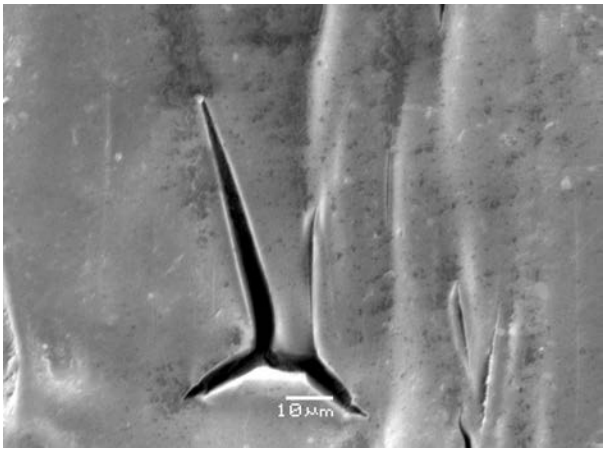

Figure4-3. SEI of Stapler (PA6) handle-surface after ten procedures of sterilisation by LHPGPS (×1000)

Cracks are observed also on the surface of stapler handle, but there is no difference between the handle surfaces sterilised five and ten times.

Discussions

We could not find the crucial factor causing the changes on some plastic panels after LHPGPS and LHPVS sterilisations. However, at this moment we speculate that chemical effect of HP vapour or physical reaction of pre vacuum may play a role to some extent. HP sterilisation procedures cause the changes of the plastic surfaces, even in a single procedure, and there may have influenced the plastic strength and structure in some cases. Though a further study is necessary to explain the cause, this study offers significant phenomena resulting from the sterilisation in medical setting.

Conclusions

LHPGPS and LHPVS sterilisation procedures have caused the structural changes of the plastic material surfaces. A further study is required to clarify the causes.

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Conflict of interest statement: None declared.

■Reference

1) Yoshida R, Kobayashi H：Hydrogen peroxide vopour in proximity of hydrogen peroxide sterilisers. *Jpn J Environment Infect* 2011；26：239-242.
2) Yoshida R, Kobayashi H. New Findings on Hydrogen Peroxide Gus Sterilisation. JJOM 2012；33：273-284.
3) Kobayashi H, Yoshida R：Hydrogen peroxide vapourised from surface of fiberscope after low temperature hydrogen peroxide sterilisation. *JJMI* 2012；82：284-286.
4) Yoshida R, Kobayashi H, Tanaka K, Urai M. False Reaction of Chemical Indicator for Hydrogen Peroxide Vapour Sterilisation. JJMI 2011；81：414-420.
5) Yoshida R: Residual Hydrogen Peroxide on Plastic Materials After Low-Temperature Hydrogen Peroxide Gas Plasma Sterilisation. JJOM 2013; 34,145-153.