Microstructural Aspects of the Silk-based Scaffolds for Tissue Engineering from the Silkworm, *Bombyx mori*

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ABSTRACT

- Animal Silk has been known to be biodegradable and less toxic to the human body, and has excellent mechanical properties in terms of strength, elasticity and flexibility.
- Recently, the composite structure and its properties of silkworm cocoon are attracted by several researches.
- In order to observe the structural characteristics of the scaffold according to the fabricating method, in this study, a silk solution was prepared from silks for fabricating scaffolds such as films, sponges, and membranes after degumming process.
- The solution was fabricated as scaffolds through freeze-drying and dip-coating methods.
- Finally, the fine structure of the various silk scaffolds were observed using light and field emission scanning electron microscopy (FESEM).
- Our microscopic observation show film scaffolds with a flat surface and sponge scaffolds with numerous round pores.
- It was found that the difference in the fine structural characteristics of each silk-fabricated scaffolds was depended on the fabrication method rather than the composition of the silk.

MATERIALS & METHODS

- Solution has been transformed into various scaffolds such as sponges, films, and tubes for the application of silk-based biomaterials for tissue engineering such as cartilage, ligaments, and blood vessels.
- To understand the mechanical properties of regenerated silk biomaterials, cocoon silks were fabricated after degumming process to remove sericin, and the fabricated scaffolds were transformed into tubes, sponges, and films by freeze-drying and dip-coating methods.
- Samples were coated to a thickness of approximately 20 nm with gold-palladium alloy using a sputter coater and examined on a Hitachi FE 4300 scanning electron microscope operated with accelerating voltage of 15 kV.

RESULTS

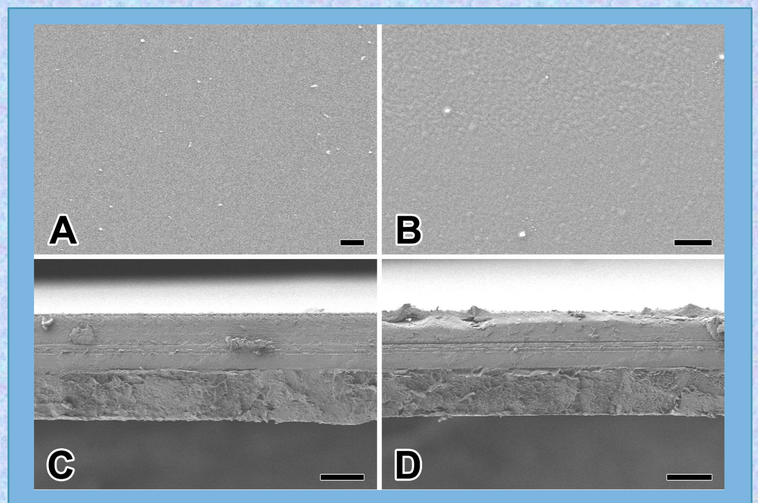

Fig. 1. Scanning electron microscopic images of 8 wt % silk film.
A, B : A flat surface of the silk film is observed. C, D : A dense cross-section of the silk film is observed in two layers.
Scale bars indicate 2 μm (A), 1 μm (B), and 20 μm (C,D).

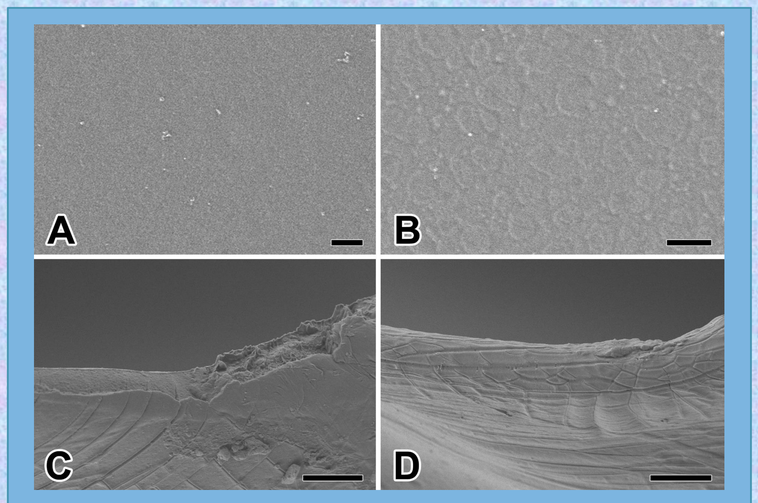

Fig. 2. Scanning electron microscopic images of 8 wt % silk film treated with ethanol.
A, B : A flat surface of the silk film is observed. C, D : A denser cross section of the silk film was observed than in the case of no ethanol treatment.
Scale bars indicate 2 μm (A), 1 μm (B), and 10 μm (C,D).

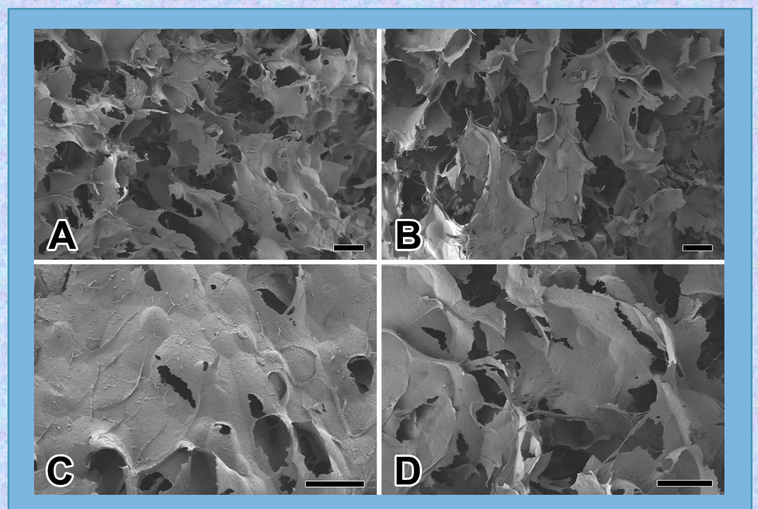

Fig. 3. Scanning electron microscopic images of 4 wt % silk sponge.
Round pores were observed in the wall of the sponge.
All scale bar indicates 100 μm.

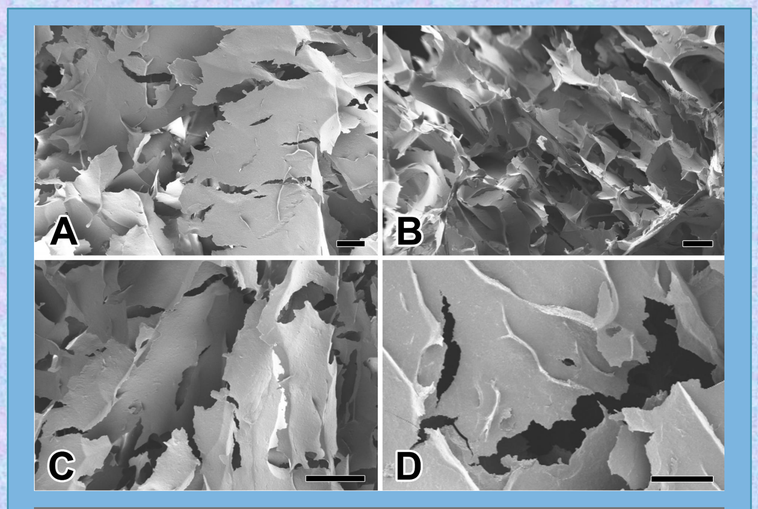

Fig. 4. Scanning electron microscopic images of 8 wt % silk sponge.
Round pores were observed in the wall of the sponge.
All scale bar indicates 100 μm.

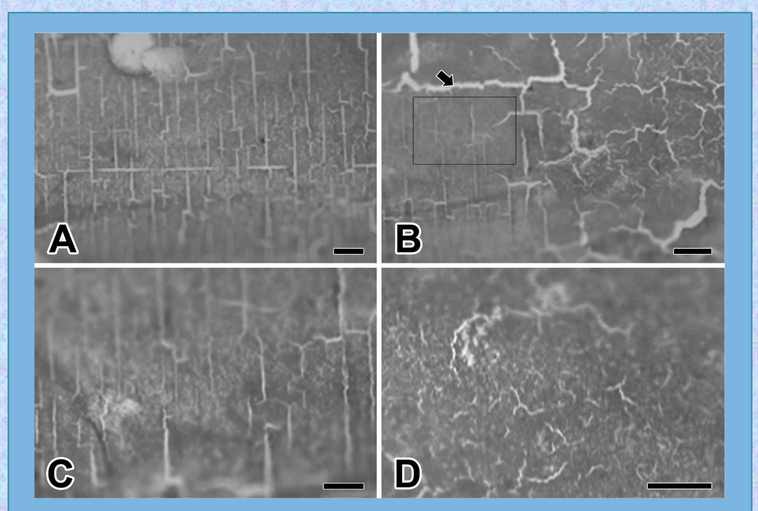

Fig. 5. Light microscopic images of a tube made of a mixture of silk solution and spider silk solution on a polyethylene stick. The rectangle represents the surface of the silk tube. A arrow indicate unconnected parts of the silk tube.
Scale bars indicate 200 μm (A,B) and 100 μm (C,D).

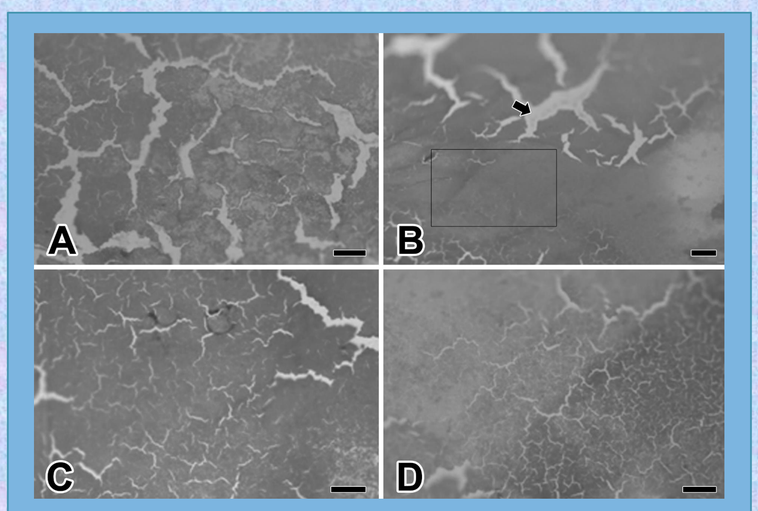

Fig. 6. Light microscopic image of a tube made of cocoon silk solution on a polyethylene stick. The rectangle represents the surface of the silk tube. A arrow indicate unconnected parts of the silk tube.
Scale bars indicate 200 μm (A,B) and 100 μm (C,D).

CONCLUSIONS

- The surface of the silk film is flat, micropatterns are observed.
- The micropattern size on the surface of the ethanol-treated silk film is increased and the cross-sectional layers are fused.
- Pores were observed in the walls of the sponge supports, and thicker walls were observed with higher silk concentrations.
- A denser and harder surface was observed than the cocoon silk-only tube.
- There were differences in microstructural characteristics according to the method of fabrication the silk scaffold.

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