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EVALUATION OF ANTIBACTERIAL ACTIVITIES FOR POLY-DL-LACTIC ACID NANOSHEET ON THE BIOMIMETIC SHARKSKIN

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ABSTRACT

The purpose of this study is to quantitatively examine whether antimicrobial activity varies with the thickness of the PDLLA nanosheets when placed on a PDMS surface with or without biomimetic shark skin surfaces. Sharks are known to have an antifouling property due to the rivulet structure of grooves spaced tens of µm apart covering their skin. The riblet structure reduces the area to which organisms adhere and prevents contact with small dirt and bacteria. In this study, a PDMS elastomer-embedded stamping method consisting of polydimethylsiloxane PDMS was used to achieve the biomimicry of sharkskin. The surface morphology before and after the nanosheet was applied was then observed with a scanning electron microscope to create a bacterial mass reference line to evaluate its antimicrobial activity. As a result, a decrease in antimicrobial activity was observed in the biological model compared to the flat surface. In addition, a small decreasing trend in antimicrobial effect was seen when the film thickness exceeded 100 nm in nanosheets with different film thicknesses, indicating that the antimicrobial activity on the surface increased as the film thickness became thicker and less able to follow the surface irregularities.

Keywords: Biomimetic; Sharkskin; Nanosheet; Antibacterial

NOMENCLATURE

F	Flat PDMS
FN	Flat PDMS and nanosheet
RSS	Real sharkskin
RSSN	Real sharkskin and nanosheet
N	Negative biomimetic-skin
NN	Negative biomimetic-skin and nanosheet
P	Positive biomimetic-skin
PN	Positive biomimetic-skin and nanosheet

1. INTRODUCTION

Numerous studies have been conducted on numerous antimicrobial substances. While many antimicrobial substances have been studied by chemical action, in recent years, many studies have been conducted on antimicrobial materials that mimic the diverse surface structures of living organisms. Cicadas and sharks are representative examples. The wing surface of the insect cicada has a hexagonal arrangement of very small columnar structures called nanopillars. It is known that this has revealed the mechanism by which microbial cells are destroyed [1]. Sharks also have microscopic protrusions. Sharks have small V-shaped dermal denticles that cover their skin [2]. Not only that, but sharks also have periodic grooves spaced tens of µm apart called rivulet structures [3,4]. These two structures reduce drag and turbulent eddies when moving through water and allow water to move quickly on the skin surface [5,6,7]. In addition, shark skin is known to be antifouling. The rivulet structure reduces the area for microorganisms to attach and prevents contact with small dirt and bacteria [8,9]. We thought that further antimicrobial effect could be improved by covering a thin film made of chemically antimicrobial materials of nano-thickness on the microscopic surface structure of these organisms.

Recently, research on nanosheets, which are two-dimensional structures with a controlled film thickness of several tens of nm, has been attracting attention. Nanosheets have extremely high flexibility and adhesiveness. Because of these characteristics, nanosheets can be attached to complex uneven surfaces by physical adsorption alone, without the use of adhesives. *Okamura et al.* used a biocompatible and biodegradable organic material, polylactic acid (PLA), as the

