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Evaluating the Feasibility of Reducing Surface Contamination in Healthcare Facilities with Micro-Pattern Films

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INTRODUCTION

Environmental surfaces are frequently colonized by pathogens that can persist and be transferred to patients. A physical surface modification consisting of an ordered microscopic topography ("Sharklet") has been shown to reduce bacterial colonization without the use of antimicrobial agents, thereby offering a novel method to reduce surface contamination. In order to be applied as a covering on frequently touched environmental surfaces, the patterned film must hold up to common forms of wear, as well as be applicable to the hand-held devices, monitors, and other screens that harbor bacteria and serve as vectors for bacterial transfer. The original Sharklet pattern (ISK2x2) disrupts optical clarity, so a recently engineered alternative pattern (SK10x2) has been constructed for use on surfaces where optical clarity is required, such as electronic touch screens. This bench-top study was carried out to assess the effectiveness of an artificially damaged ISK2x2 Sharklet surface as well as the new SK10x2 pattern in reducing bacterial attachment and survival compared to un-patterned control surfaces.

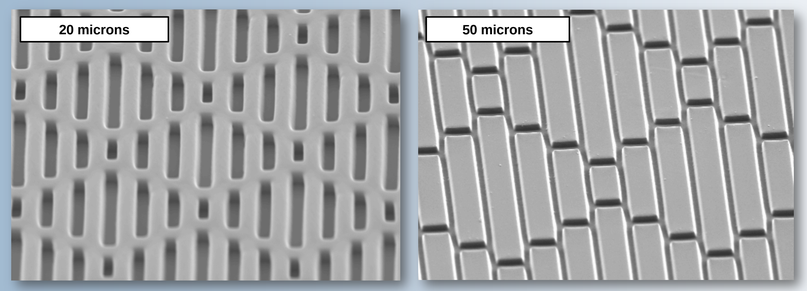


Figure 1. Scanning electron micrographs of the two Sharklet micro-patterns used in this study: ISK2x2 (left, Scale bar = 20 µm) and SK10x2 (right, Scale bar = 50 µm).

METHODS

Sharklet (ISK2x2) micro-patterned and control (smooth) acrylic films were pre-conditioned with fingernail scratches (8 scratches per 2"x2" area) or skin lotion fingerprints (16 fingerprints per 2"x2" area). Pre-conditioned and un-modified films (n=4) were exposed to ~10^3 CFU/mL *Staphylococcus aureus* (ATCC 6538) in saline for 30 minutes, followed by saline rinses to remove non-adherent cells. Agar contact plates (RODAC) were used to recover attached cells immediately after rinsing for evaluation of bacterial attachment.

Un-patterned silicone elastomer coupons (smooth) and coupons with the ISK2x2 or SK10x2 Sharklet patterns (n=4) were inoculated with ~10^7 CFU/mL *S. aureus* in saline for 30 minutes, rinsed three times with saline, and recovered via sonication for dilution plating immediately (attachment) and after 1 hr of drying (survival). CFUs were compared for percent reductions.

RESULTS

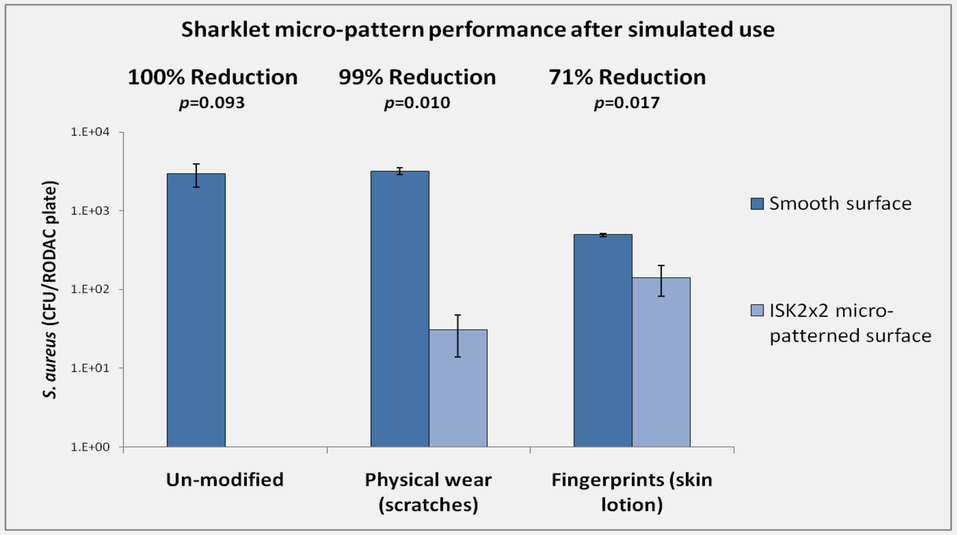
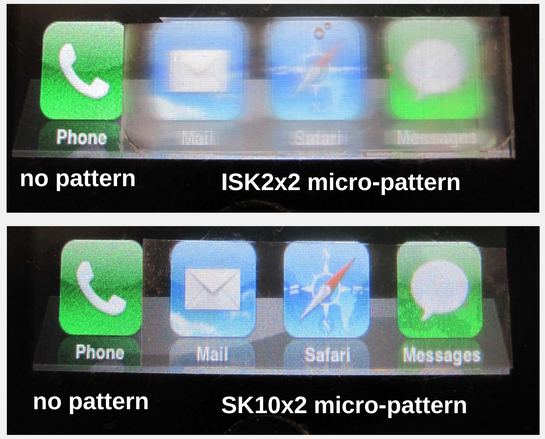


Figure 2. The ISK2x2 Sharklet pattern reduced* S. aureus *attachment despite simulated usage via physical wear (scratches) or conditioning with skin lotion (fingerprints). *Results showed that micro-patterned films continue to perform even after excessive simulated use when compared to similarly pre-conditioned smooth surfaces. Total colony counts between patterned and smooth surfaces were compared for percent reduction and statistical significance with a Student's t-test.*

		Undamaged	
		smooth	ISK2x2
Scratches	smooth	$p = 0.840$	
	ISK2x2		$p = 0.207$
Lotion	smooth	$p = 0.127$	
	ISK2x2		$p = 0.141$

Table. 1. The microbial load on the ISK 2x2 Sharklet micro-pattern did not significantly increase due to the presence of scratches or lotion. *No significant differences in* S. aureus *attachment were observed on the pre-conditioned surface when compared to an un-modified surface of the same pattern type.*

Figure 3. The SK10x2 offers improved optical clarity over the ISK2x2 Sharklet micro-pattern. *The ISK2x2 micro-patterned film (top panel) distorts the resolution of the right three icons compared to the uncovered icon on the far left when placed on top of a phone touch-screen display; the SK10x2 patterned film (bottom panel) does not distort the resolution when placed onto the same touch-screen display.*



	Attachment		Survival	
	ISK2x2 micro-pattern	SK10x2 micro-pattern	ISK2x2 micro-pattern	SK10x2 micro-pattern
% Reduction	75%	56%	55%	68%
p value	0.006	0.019	0.014	0.006

Table 2. The alternative SK10x2 Sharklet micro-patterned surface reduced* S. aureus *attachment and survival *similarly to the previously tested ISK2x2 micro-pattern (p=0.168, 0.318) when compared to a smooth surface.*

CONCLUSIONS

In a healthcare setting, micro-patterned films applied to high-touch environmental surfaces would likely experience physical wear and oily residue from hand contact. This study demonstrates that the previously studied ISK2x2 Sharklet micro-pattern offers significant bacterial inhibition even after being pre-conditioned by physical wear (fingernail scratches) and hand lotion (fingerprints).

In addition, the recently engineered SK10x2 Sharklet micro-pattern offers improved optical clarity and is just as effective in reducing microbial colonization as the ISK2x2 pattern. The results suggest that the SK10x2 pattern could be effective for reducing surface contamination on hand-held devices, monitors, and other screens that could harbor bacteria in a healthcare setting.

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