Cost-Effective Antimicrobial Surfaces Patterned by Interference and Nanoimprint Lithography

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In this work, a custom, low-cost interference lithography (IL) tool was developed for production of repeatable nano/micro-scale patterned antimicrobial surfaces. In past work, IL was combined with nanoimprint lithography (NIL) to produce micro/nanotextured surfaces with feature size and morphology that demonstrated effective antibiofouling and bactericidal properties.[1] While IL was used to quickly produce patterned areas over a few centimeters, NIL was used to pattern these patterns over larger areas. In our work, we combined these fabrication techniques to enable rapid surface feature optimization and development using an IL tool costing 50X less than other commercial options.

The IL tool developed (*Fig 1*) consisted of a Lloyd's mirror interferometer[2] which was used to create surfaces with linear periodic features consisting of a duty cycle of 50%, and periods ranging from 250 to 1500 nm (*Fig 2*). At present, we are patterning silicon wafer substrates (*Fig 3)* that will be subject to a physical etch by reactive ion etching (RIE). Following RIE processing, NIL will be used to transfer the pattern to clear polycarbonate substrates (*Fig 4).* Several periodic spacings will be fabricated on the polymer surfaces and tested in triplicate to determine effective antimicrobial activity. Each surface will be sterilized by ultraviolet light for 30 minutes before coating with *Staphylococcus aureus* (10^4 cells) in tryptic soy broth media. The surfaces will also be coated with *Pseudomonas aeruginosa* (10^4 cells). Bacterial growth will be monitored over 24 hours at 37 °C before bacteria are subject to live-dead staining and quantified by confocal microscopy.

The presented work will include morphological characterization by electron microscopy and atomic force microscopy. This work will provide foundational data correlating surface features and antimicrobial properties for application in utilizing a low-cost IL system and NIL for efficient fabrication and design of antimicrobial surfaces. This work will provide foundational data correlating surface features and antimicrobial properties for application in utilizing a low-cost IL system and NIL for efficient fabrication and design of antimicrobial surfaces. We intend to provide an economically feasible method that enables production of bactericidal surfaces for applications like hospitals and schools with no apparent visible or tactile modifications.

[1] A. Muñoz-Bonilla and M. Fernández-García, European Polymer Journal 65, 46 (2015)

[2] H. Korre, On the Development of a Low-Cost Lithographic Interferometer(2010)

Figure 1: Image of the Lloyd's mirror interference lithography system.

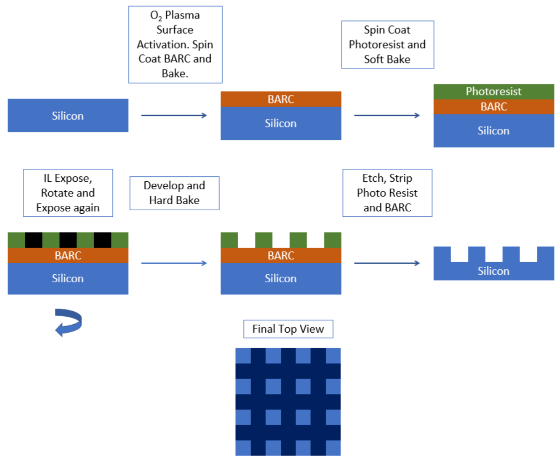

Figure 2: Process flow for fabrication of NIL master stamps using interference lithography.

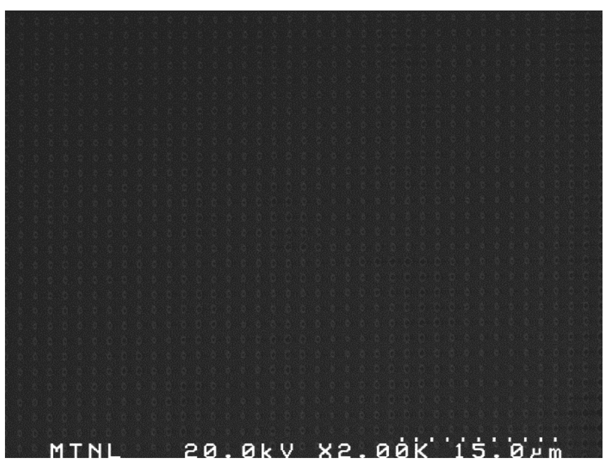

Figure 3: Top-down image of patterned photoresist pillars on silicon wafer at 2kX magnification.

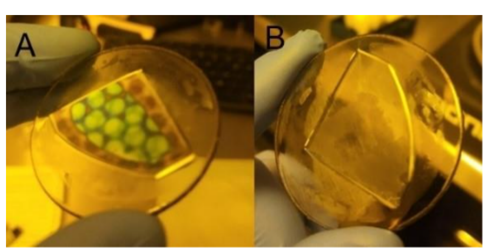

Figure 4: An imprinted polycarbonate substrate patterned by NIL before master stamp removal (A) and the polycarbonate substrate after NIL and master stamp removal (B).