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PII: S0169-4332(15)00451-1
DOI: http://dx.doi.org/doi:10.1016/j.apsusc.2015.02.135
Reference: APSUSC 29815

To appear in: *APSUSC*

Received date: 24-10-2014
Revised date: 20-2-2015
Accepted date: 21-2-2015

Please cite this article as: H. Ems, S. Ndao, Microstructure-alone induced transition from hydrophilic to hydrophobic wetting state on Silicon, *Applied Surface Science* (2015), http://dx.doi.org/10.1016/j.apsusc.2015.02.135

Microstructure-alone induced transition from hydrophilic to hydrophobic wetting state on Silicon

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Key Words: hydrophobic, re-entrant microcavitites, wetting transition, air entrapment

ABSTRACT

Surface hydrophobicity is primarily attained through the use of low surface energy materials. Experimental attempts to turn hydrophilic surfaces to hydrophobic have consisted of coating and thin film deposition. However, in many applications low surface energy materials and coatings are not practical, though hydrophobicity is still desired. In this paper, we demonstrate the transition from hydrophilic to hydrophobic wetting states for an intrinsically hydrophilic surface (contact angle less than 45 degrees) using only surface microstructuring. The surface microstructures consist of re-entrant microcavities which interfere with the complete wetting of the surface, causing a liquid droplet to sit on the surface in a Cassie wetting state. The microstructures were fabricated on a Silicon-On-Insulator (SOI) wafer through steps of photolithography, etching, and bonding. Contact angle measurements demonstrated the ability of the microfabricated surfaces to sustain large contact angles above 100 degrees, compared to a bare silicon surface which has a contact angle around 40 degrees. Energy-dispersive X-ray spectroscopy showed Silicon to be the only chemical element on the surface, while optical observations with an inverted microscope hinted to the existence of a Cassie wetting state.

1. Introduction

The ability to control the wetting state between a surface and a liquid is very important in many applications, such as heat transfer (e.g., boiling, condensation), microfluidics (e.g., self-propelled droplet), antifouling, and self-cleaning surfaces. The wetting state of a surface is often