Nanostructured Titania and Micromachined Titanium for Thermal Management in Microelectronics

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Thermal management technologies are critical to the development of high power / flux devices such as photovoltaics and power amplifiers. The large latent heat of vaporization makes two-phase cooling technologies attractive for thermal management of microelectronic components. A notable trend in the development of thermal management technologies today is the incorporation of nanotechnologies through various approaches. One approach is the use of nanoparticles. It has been shown that when nanoparticles are deposited on heater surfaces, there is significant improvement in the critical heat flux which was attributed to improvement in surface wettability [1]. Another approach to improve heat transfer is the use of microstructured surfaces with well-defined surface roughness. Using undoped Si pillars, Chu et. al. reported enhancement in critical heat flux of up to 160%. It was reported that for such microstructured surfaces, enhancement of critical heat flux was due to roughness-amplified capillary forces [2]. Here we describe our approach in which nanostructured titania (TiO_2) are formed on surfaces of high-aspect ratio micropillars of Ti. The nanostructured titania formed are porous – with pores in the range of tens of nanometers – and hydrophilic in nature. The process to fabricate micropillars of Ti using dry etching techniques as well as a simple process to integrate nanostructured on surfaces of these Ti micropillars will be discussed [3,4]. Our results point to potential application of nanostructured titania on micromachined Ti structures for thermal management of electronic devices.

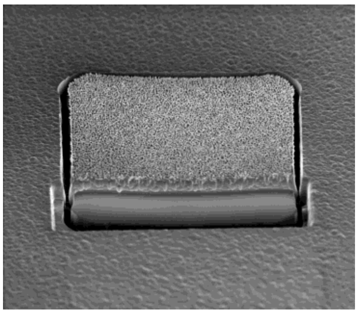

Fig.1 – Nanostructured titania on patterned Ti.

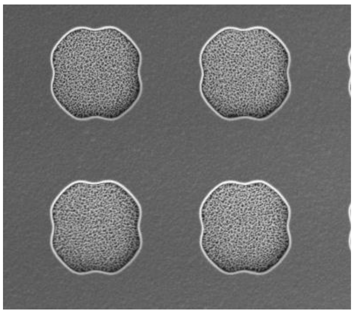

Fig.2 – Nanostructured titania on oxidised Ti micropads.

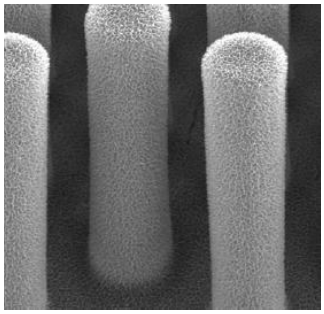

Fig.3 – Nanostructured titania on micropillars of Ti.

References

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Biography

Zuruzi Abu Samah earned his PhD from the Materials Department at the University of California, Santa Barbara. Upon graduation, he obtained a post-doctoral fellowship at Agilent Laboratories (USA) before joining Intel as a senior engineer in Phoenix, AZ. Prior to joining Singapore University of Technology and Design (SUTD), where he is currently a Senior Lecturer in the Engineering Product Development Pillar, Zuruzi was a senior academic staff at Nanyang Polytechnic. His areas of interest include materials and processing of MEMS devices.

Hannah Gardner is a Lecturer at Nanyang Polytechnic. Her research interests lie in the areas nanostructured materials and their application in photovoltaics. Before moving to Singapore, Hannah carried out research at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australia. Hannah holds a MCHEM (Hons) from the University of Sheffield, UK and a PhD in nanotechnology and advanced materials from Cranfield University, UK.

Noel C. MacDonald is a Professor in the Department of Mechanical and Environmental Engineering, University of California, Santa Barbara (UCSB). Before joining UCSB, he held the Acheson/Laibe Professorship in Engineering at Cornell University, Ithaca, NY, and he served as the Director of the Cornell Nanofabrication Facility and the Chairman of the School of Electrical Engineering, Cornell University. From 1997 to 1999, he served as the Director of the Microsystems Technology Office at the Defense Advanced Research Projects Agency.