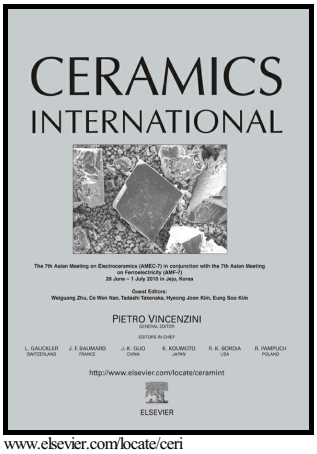

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Porous silicon pillar and bilayer structure as a nucleation center for the formation of aligned vanadium pentoxide nanorods

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Abstract

Porous silicon single layer (PSM), bilayer (PSB) and pillar (PSP) structures have been evaluated as nucleation centers for vanadium pentoxide (V_2O_5) crystals. Deposition of vanadium precursor over different substrates (drop casting technique), followed by annealing treatment under Ar-H_2 (5% H_2) atmosphere, induced crystallization of vanadium oxide. With respect to c-Si/SiO_2 substrate, V_2O_5 nanorods with relatively large aspect ratio were formed over and within PSP structures. On the other hand, pores in PSM and PSB were found to be filled with relatively smaller crystals. Additionally, PSB provided a nucleation substrate capable to align the nanocrystals in a preferential orientation, while V_2O_5 crystals grown on PSP were found to be randomly aligned around the nanoporous pillar microstructure. Nanorods and nanocrystals were identified as V_2O_5 by temperature-controlled XRD measurements and evidence of their crystalline nature was observed via transmission electron microscopy. A careful analysis of electronic microscopy images allows the identification of the facets composing the ends of the crystals and its corresponding surface free energy has been evaluated employing the Wulff theorem. Such high surface area composite structures have potential applications as cathode material in Lithium-ion batteries.

Keywords

Porous silicon, Vanadium Pentoxide, nanorods, crystallization, nanostructures

1. INTRODUCTION

Vanadium pentoxide (V_2O_5) is a transition-metal oxide which owns a wide range of properties such as high oxidation state (5^+), thermal stability, thermoelectric behavior, high specific capacity and large optical band gap [1,2,3]. Some vanadium oxide compounds