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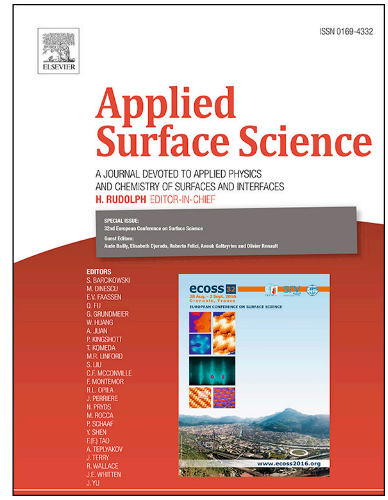

Full Length Article

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Suppression of self-organized surface nanopatterning on GaSb/InAs multilayers induced by low energy oxygen ion bombardment by using simultaneously sample rotation and oxygen flooding

Georges Beainy[1,2], Tiphaine Cerba[2], Franck Bassani[2], Mickaël Martin[2], Thierry Baron[2], Jean-Paul Barnes[1]

[1] *Univ. Grenoble Alpes, F-38000 Grenoble, France*
CEA LETI, MINATEC Campus, F-38054 Grenoble, France
[2]*Univ. Grenoble Alpes, LTM, F-38000 Grenoble, France and CNRS, LTM, F-38000 Grenoble, France*

Abstract

Time of flight secondary ion mass spectrometry (ToF-SIMS) is a well-adapted analytical method for the chemical characterization of concentration profiles in layered or multilayered materials. However, under ion beam bombardment, initially smooth material surface becomes morphologically unstable. This leads to abnormal secondary ion yields and depth profile distortions. In this contribution, we explore the surface topography and roughening evolution induced by O_2^+ ion bombardment on GaSb/InAs multilayers. We demonstrate the formation of nanodots and ripples patterning according to the ion beam energy. Since the latter are undesirable for ToF-SIMS analysis, we managed to totally stop their growth by using simultaneously sample rotation and oxygen flooding. This unprecedented coupling between these two latter mechanisms leads to a significant enhancement in depth profiles resolution.

Introduction

Recent progress in materials science necessitates knowledge and control of matter at the nanometer scale. Nowadays, given the complexity of the devices in terms of chemical composition as well as in dimension, their accurate characterization has become difficult and sometimes challenging. For this purpose, Time of Flight Secondary Ion Mass Spectrometry (ToF-SIMS) has become a crucial tool that is well adapted analytical method for the chemical characterization of concentration profiles in layered or multilayered materials. However, the reliability and accuracy of the interface characterization may be affected by methodological factors, which alter the depth resolution such as: macroscopical or microscopical initial roughness of the material and ion bombardment induced surface topography and roughening. In fact, material surface of initially smooth monocrystals becomes morphologically unstable under ion bombardment. This instability leads to the formation of self-organized nanostructures on the surface of the material such as nanoscale ripples [1], [2], [3], [4] and dots [5], [6], [7], [8]. These nanostructures on semiconductors surface have attracted much interest due to their potential applications in low-dimensional devices, particularly as ordered quantum nanodots for optoelectronics and quantum devices [9], [2], in magnetic storage technology [10] and for selective attachment of specific molecules [11]. On the other hand, extensive efforts in the form of experimental as well as theoretical studies have been devoted to understand the fundamental processes of ripples and dots formation on surfaces subjected to energetic ion bombardment [12]. The pioneering works by Bradley and Harper [13] referred to as BH model was the first successful theoretical approach to explain the ripple

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