11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Au-Pd bilayered films deposited on Si(111) and GaAs(100) substrates

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Abstract – Pd and Au films, having a thickness of 10 nm, were deposited by dc sputtering on 100 nm thick layers of Au and Pd, respectively, which were grown on Si(111) and GaAs(100) substrates. The structure, morphology, and chemical composition of the films were analyzed by X-ray reflectometry (XRR), X-ray diffraction (XRD), atomic force microscopy (AFM), and X-ray photoelectron spectroscopy (XPS). AFM images showed flat surfaces for the Au films, while the Pd films presented surfaces covered by small grains. XPS results indicated that the Pd thin films were partially oxidized, while the Au thin films were metallic.

Bimetallic systems have been widely studied due to their applications as catalysts, in magnetic and electronic devices, and chemical sensors [1]. Palladium metallization is used to form ohmic contacts in semiconductor devices. However, using Pd as the topmost layer may cause difficulty due to its reactivity [2]. The reactive Pd surface can be passivated by a gold layer, since Au is stable and inert and thus can be used as a protective material [2].

In a previous study, we deposited by dc magnetron sputtering 10 nm thick Pd and Au films on polycrystalline Au and Pd foils, respectively, and characterized the structure, morphology and composition of the films, concluding that these characteristics depend on the substrate [3]. Alloying was not detected for either case.

In the present work, the Au-Pd bilayers were deposited on Si(111) and GaAs(100) substrates by dc sputtering, using a Balzers BA 510 equipment. First, a 100 nm thick layer of Pd (Au) was deposited on the substrate surface, having WTi as adhesive layer, then a 10 nm thick film of Au (Pd) was grown. The structure, morphology, and chemical composition of the films were analyzed by X-ray reflectometry (XRR), X-ray diffraction (XRD), atomic force microscopy (AFM), and X-ray photoelectron spectroscopy (XPS). XRD results were obtained in a Rigaku diffractometer using Cu Kα (λ = 0.15418 nm) monochromatic radiation. The AFM analyses were carried out in contact mode, using a Digital Nanoscope IIIA instrument. XPS measurements were performed in ultra high vacuum (low 10^{-7} Pa range) using a Kratos XSAM HS spectrometer. Non-monochromatic Mg Kα ($h\nu$ = 1253.6 eV) radiation was used.

The nominal and real thicknesses of the Pd and Au thin films differed very little. The lattice parameters of the Pd films were larger than the standard value, while Au films presented an opposite trend, showing the interface constraint on the crystal structure of the films. The AFM images showed flat surfaces for the Au films, while the Pd films presented surfaces covered by small grains (particles). XPS results indicated that the Pd thin films were partially oxidized, while the Au thin films were metallic.

References

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