XPS and GDOES analysis of native oxide layers on n-GaSb (100) surface- application to depth profiling of AuGeNi/n-GaSb

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AIM: ***For this period of modern semiconductor industry development, GaSb is of special interest as a substrate material for optoelectronic applications as laser diodes, photodetectors with high efficiency or high efficiency thermophotovoltaics (TPV) cells. GaSb is an III-V semiconductor compound with zinc blende crystal structure with the band gap of 0.726 eV. The performance and reliability of GaSb devices depend on surface preparation techniques. This work is dedicated to the study of characteristics of metal nanometric layers deposited on as prepared GaSb surface in order to develop a viable route in the technology of ohmic and Schottky contacts on n-GaSb (100), active as a photosensitive structure.***

EXPERIMENTAL: n- GaSb surface was prepared for Au/Ge/Ni contact layer deposition by a controlled chemical etching procedure. Metal layers : Au(140nm)/Ge(72nm)/Ni(14nm) were deposited in medium vacuum conditions (p~10 $^{-5}$ torr) and annealed in temperature range (300-320)ºC. Metal layers viewed as ohmic contact were exposed to controlled depth profiling by Ar+ ion etching. Characteristics of nanometric deposited metals were investigated by XPS and GDOES analysis and AFM method

CHARACTERISTICS OF Au/Ge/Ni layers

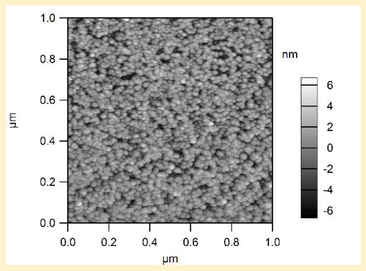


FIG.1- linitial surface aspect of GaSb as a conglomerate of Ga and Sb oxides defining a surface roughness of 1.854 nm

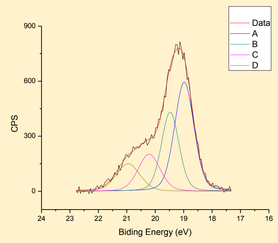


FIG.2- XPS spectrum of Ga 3d lines on native oxides. Composition : 71.5 % Ga in GaSb and 28.5% Ga in Ga oxide

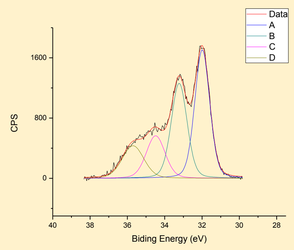


FIG.3- XPS spectrum of Sb 4d3/2 and Sb 4d5/2 on GaSb native wafer. Composition : 71.1% Sb in GaSb and 28.8% Sb in Sb oxide

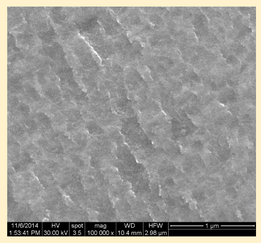


FIG.4- SEM image of GaSb chemical etched surface

CONTROLLED DEPTH PROFILING BY Ar+ iON ETCHING

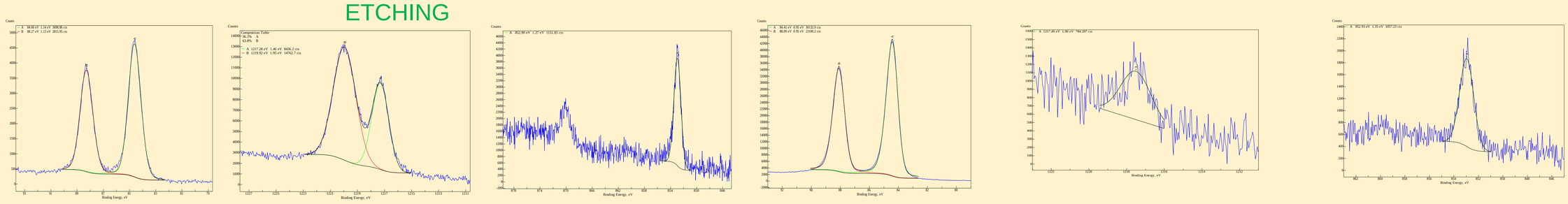


FIG.5 XPS spectra of Au 4f (left) Ge 2p (middle) and NI2p (right) lines after vacuum deposition (Initial stage)

FIG.6 XPS spectra of Au, Ge Ni lines after 16-th ion beam etching

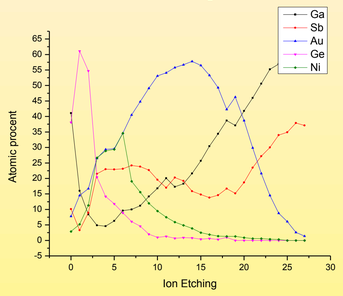


FIG.7 Depth profiling of Au/Ge/Ni in the 28 ion beam etchings controlled by XPS analysis

FiG.8 Optical image of AuGeNi/ GaSb surface after ion bean etching

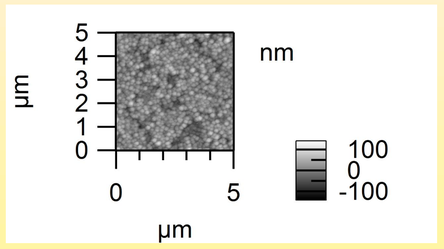


FiG.9 AFM aspect of AuGeNi/GaSb after Ar ion beam etching

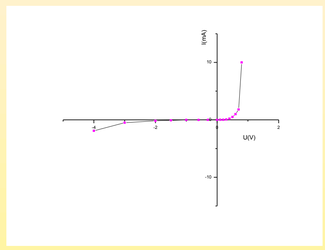


FiG.10 I-V characteristics of MBE Ni/GaSb Schottky diode (Ni thickness ~ 2 nm). This sample had a AuGeNi ohmic contact

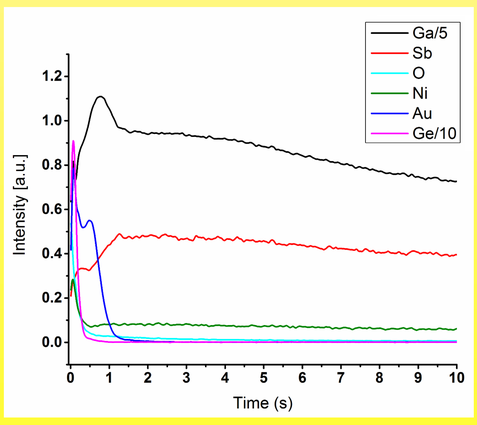
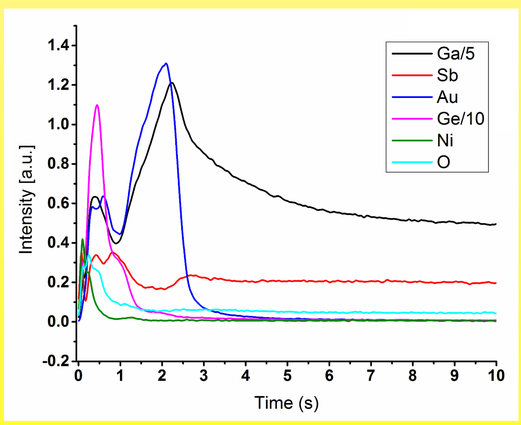


FIG.11 (left)-GDOES spectrum on the sample exposed to Ar⁺ ion etching
FIG.12 (right)- GDOES spectrum –depth profiling for AuGeNi/GaSb
It is observed the interface zone where there is concentration variation for Au, Ge,Ni and there is a signal from Sb oxide



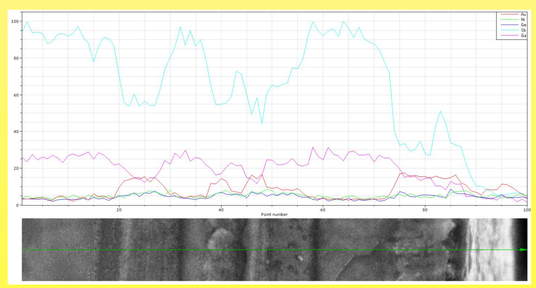


FIG.13 SEM image and elemental distribution on AuGeNi / GaSb interface

CONCLUSION- Au/Ge/Ni /n-GaSb deposition was subjected to an extended characterization in order to obtain the experimental conditions for defining good ohmic and Schottky metal contacts in nanometric range

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