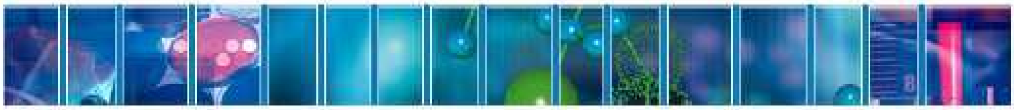

E·MRS

2012 Spring Meeting

May 14 – 18
Strasbourg, France

PROGRAMME

CONFERENCE SYMPOSIA

MATERIALS FOR ENERGY

A	Advanced Silicon Materials Research for Electronic and Photovoltaic Applications III
B	Thin Film Chalcogenide Photovoltaic Materials
C	Solid State Ionics: Mass and Charge Transport across and along Interfaces of Functional Materials
D	Unconventional Thermoelectrics: from new materials to energy conversion devices
E	Actinide compounds and properties
F	Solid proton conductors (In honor of Prof. G. Alberti)

BIO / ORGANIC / POLYMERIC MATERIALS

G	Functional Biomaterials
H	Organic and Hybrid Materials for Flexible Electronics: Properties and Applications
I	Biological applications for organic electronic devices
J	DNA Directed Programmable Self-assembly of Nanoparticles into Meta Materials for energy and other applications
K	Surface modifications of carbon-related materials II

MATERIALS FOR ELECTRONIC / PHOTONIC / PLASMONIC

L	Novel Functional Materials and Nanostructures for innovative non-volatile memory devices
M	More than Moore: Novel materials approaches for functionalized Silicon based Microelectronics
N	Control of light at the nanoscale: materials, techniques and applications
O	Applied Nanoplasmonics: Nanoplasmonic Functional Materials and Devices

ADVANCED MATERIALS AND NANO MATERIALS

P	Advanced Hybrid Materials II: design and applications
Q	Novel materials and fabrication methods for new emerging devices
R	Science and technology of nanotubes, graphene and 2D layered materials
S	Novel materials for hetereogeneous catalysis
T	Physics and Applications of Novel gain materials based on Nitrogen and Bismuth Containing III-V Compounds
→ U	Carbon- or Nitrogen-Containing Nanostructured Thin Films

METHODS AND ANALYSIS

V	Laser materials processing for micro and nano applications
W	Current Trends in Optical and X-Ray Metrology of Advanced Materials for Nanoscale Devices III
X	Quantitative Microscopy of Energy Materials
Y	Advanced materials and characterization techniques for solar cells

evaluated by measuring force required to separate AFM tip from surface by means of AFM force-distance curves. The functional group analysis of a-C:H/PVP interface employing Fourier transform infrared spectroscopy (FTIR) is performed to study the blend behavior of PVP upon a-C:H direct ion beam deposition. The changes involved in reflectance behavior of the films in UV/VIS range are discussed.

✚ **add to my program** **(close full abstract)**

16:00

Correlation of amorphous carbon and doped amorphous carbon thin films optical properties with the chemical composition of the films

Authors : Asta Tamulevičienė*, Šarūnas Meškinis*, Vitoldas Kopustinskas*, Sigitas Tamulevičius*, Frans Munnik**

Affiliations : *Institute of Materials Science of Kaunas University of Technology, Savanorių pr. 271, LT- 50131 Kaunas, Lithuania **Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstr. 400, D-01328 Dresden, Germany

Resume : Amorphous carbon films have attracted particular attention because they can provide a wide range of exceptional physical, mechanical, optical, electrical and tribological properties that make them suitable for numerous applications. Doping of these films is possible with different elements or compounds: Si, SiOx, Ag, Ni, Ti, TiO2 and etc. Wide range of film properties (mechanical, optical, tribological, etc.) depend on the chemical composition and sp3/sp2 bond ratio in the films. The amount of hydrogen in the film plays an important role also. In this work we present the analysis of chemical composition (including hydrogen) determined by Elastic recoil detection analysis of different type of amorphous carbon deposited employing closed drift ion beam source: 1) a-C:H (made from acetylene (C2H2) -conventional amorphous carbon); 2) a-C:H:SiOx (made from hexamethyldisiloxane (HMDSO) with hydrogen/helium carrier gas); 3) a-C:H:SiOx (made from HMDSO with C2H2 carrier gas). The ion beam source energy was changed from 300 to 800 eV. The correlation of chemical composition with the optical properties of the films is analysed. Structure of the films was analysed employing Raman and FTIR spectroscopy. It was determined that the chemical composition varies slightly with the change in ion beam energy. More drastical variations in chemical composition were observed when carrier gas was changed. 14 12

✚ **add to my program** **(close full abstract)**

16:00

Properties of MeNxOy thin films prepared by reactive DC magnetron sputtering

Authors : J. Borges, F. Vaz, L. Marques

Affiliations : Centre/Department of Physics, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal

Resume : The addition of small amount of nitrogen to a growing MeOy (Me = Metal) film originates a new class of materials with a wide range of different properties, where the optical, electrical and mechanical ones may be tailored between those of the pure oxide, MeOy, and oxynitride, MeNxOy, films, according to the particular application envisaged. The main reason for this is related with the change in the nitride content (which can be either metallic or even insulating-type) of the films promoted by the increasing amounts of nitrogen that are introduced in the films. In this work thin films of MeNxOy were produced using reactive DC magnetron sputtering, using a metallic (Me) target and an Ar/(N2,O2) gas mixture. Preliminary results revealed that the incorporation of nitrogen in the MeOy matrix induces the production of films with electrical and optical responses rather different than the pure oxide that are strongly correlated with its structural arrangement, chemical composition and morphology changes. On one hand the electrical resistivity and temperature coefficient of resistance were found to have a wide variation, which can be explained using a tunnel barrier conduction mechanism for the electric charge transport through the film, with possible applications in microelectronic devices. The particular morphology of the films induced a broadband optical response with high optical absorption from 290 to 2500 nm, with potential applications in solar cells and thermal photovoltaics. 14 13

✚ **add to my program** **(close full abstract)**

16:00

Plasma synthesis of copper-polythiophene nanocomposites and their characterization

Authors : V. Satulu, V. Ion, A. I. Lazea, L. C. Nistor1, B. Mitu*, G. Dinescu 14 14

Affiliations : National Institute for Lasers, Plasma and Radiation Physics, Atomistilor 409, 77125 Bucharest-Magurele, Romania 1 National Institute for Materials Physics,

PROPERTIES of MeN_xO_y THIN FILMS PREPARED by DC MAGNETRON SPUTTERING
(The case of AlN_xO_y)

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[1]Centre of Physics and Department of Physics, Campus de Gualtar, 4710-057 Braga, Portugal

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In this work a set of films of AlN_xO_y and two sets of the correspondent binary systems, AlN_x and AlO_y, were produced using reactive DC magnetron sputtering, using an aluminium target and an Ar + (N_2 +/or O_2) gas mixture. The discharge characteristics (target potential) and deposition rate, chemical composition, structure, electrical and optical properties of the ternary system were compared to those of the binary systems in order test whether the oxynitride films have a unique behaviour or is simply a transition between AlN_x and AlO_y.

DEPOSITION TECHNIQUE

DC magnetron sputtering
Target: Aluminium, 99,6 % purity
Substrates: Glass, Silicon <100>
Substrate temperature before plasma: 373 K
Partial pressure of Argon: 0.3 Pa
Reactive gas: N_2; O_2 and N_2+O_2 (17:3)
Rotating substrates: 9 r.p.m.
Bias: GND
Target current density: 75 A.m^{-2}
Discharge parameters monitored by a Data Acquisition/ Switch unit Agilent34970A

DEPOSITION CHARACTERISTICS

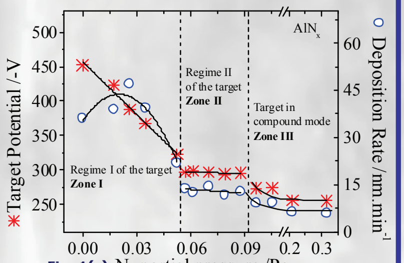

Fig. 1(a)

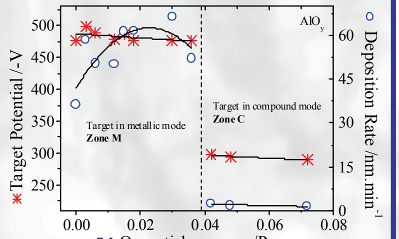

Fig. 1(b)

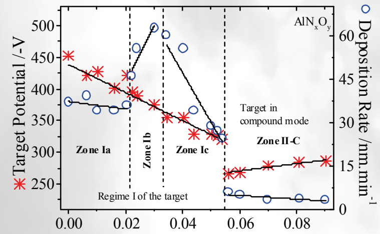

Fig. 1(c)

Fig. 1 Target potential and deposition rate of (a) AlN_x, (b) AlO_y and (c) AlN_xO_y systems.
The Target Potential is clearly influenced by the gas mixture partial pressure. In the AlO_y system the transition from a clean target to completely poisoned is very abrupt, while in the AlN_x and AlN_xO_y systems the transition is smoother.
The deposition rate (thickness/deposition time) has also distinct variations in each system.

RESULTS AND DISCUSSION

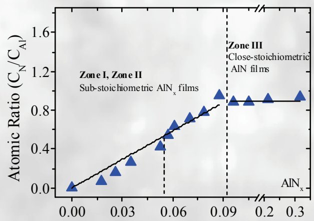

Fig. 2(a)

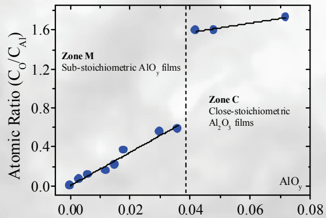

Fig. 2(b)

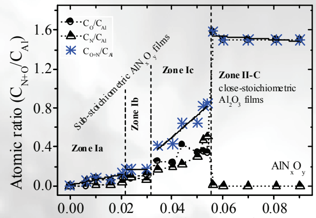

Fig. 2(c)

Fig. 2 Atomic ratio of (a) AlN_x, (b) AlO_y and (c) AlN_xO_y systems.
The transition from sub-stoichiometric towards close-stoichiometric films is relatively smooth in AlN_x, very abrupt in AlO_y, and different tendencies can be found in AlN_xO_y system according to the particular zones identified.

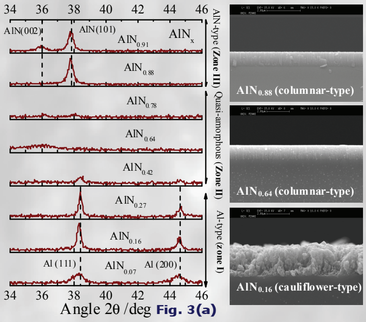

Fig. 3(a)

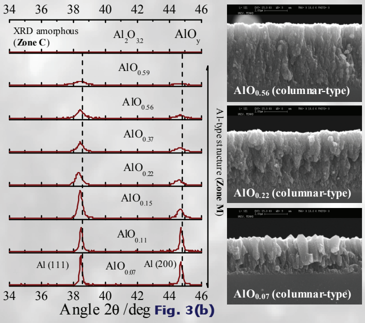

Fig. 3(b)

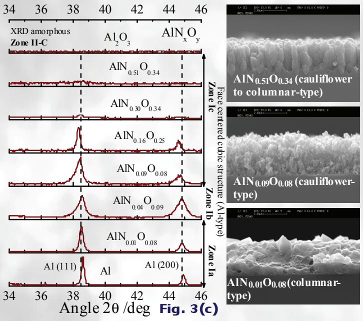

Fig. 3(c)

Fig. 3 XRD and representative SEM cross sections of (a) AlN_x, (b) AlO_y and (c) AlN_xO_y systems.
In the AlN_x system an Al-type structure is observed for low stoichiometries (zone I), then the films become XRD amorphous (zone II) and finally crystallize in a hexagonal (*wurzite*) structure (AlN-type structure). The sub-stoichiometric AlO_y films (Zone M) are also composed of Al crystals, becoming XRD amorphous when close-stoichiometric Al_2O_3 films are formed (Zone C). In the AlN_xO_y system the Al-type structure is maintained in the sub-stoichiometric films (Zone Ia, Ib), becoming amorphous in zone Ic, ending up completely amorphous in zone II-C (again close-stoichiometric Al_2O_3 films).
A non-columnar growth was found in some films with Al-type structure. These films, with cauliflower-like growth, are porous, which may explain the high deposition rates observed in some films.

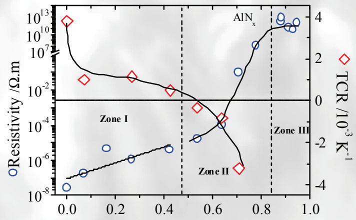

Fig. 4(a)

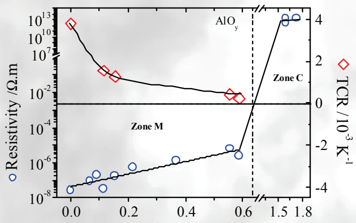

Fig. 4(b)

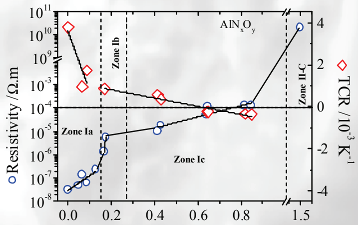

Fig. 4(c)

Fig. 4 Electrical resistivity and temperature coefficient of resistance (TCR) of (a) AlN_x, (b) AlO_y and (c) AlN_xO_y systems.
The electrical resistivity gradually increases 3-4 orders of magnitude in the films with Al-type structure. It increases further with the rise of the atomic ratio towards semi-conductor and insulator-type resistivities.
The TCR, measured for the high conductive samples, decreases with the increase of the atomic ratio and can even be negative in the systems with nitrogen, AlN_x and AlN_xO_y.

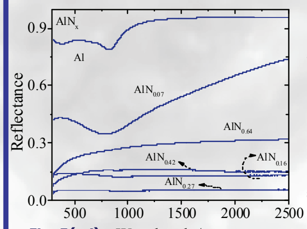

Fig. 5(a-i)

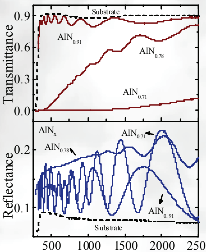

Fig. 5(a-ii)

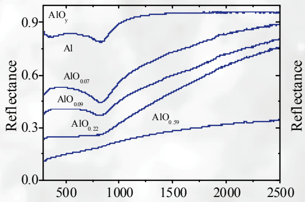

Fig. 5(b)

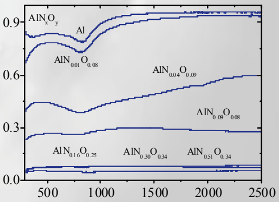

Fig. 5(c)

Fig. 5 Reflectance and transmittance of (a-i and a-ii) AlN_x system and reflectance of (b) AlO_y and (c) AlN_xO_y systems.
The films indexed to zone I of the AlN_x system are opaque and the typical interband absorption of aluminium at ~800 nm can be observed. The reflectance drops from the typical Al profile towards very low values. In zone II, as the atomic ratio increases, the reflectance increases again and interference fringes can be observed for higher ratios. The films become semi-transparent, ending up with a very high transmittance in zone III. In AlO_y system, the films indexed to zone M are opaque with a marked decrease of the reflectance, becoming transparent in zone C (as expected since the films have Al_2O_3-type compositions). In AlN_xO_y system the reflectance also drops to low values as the atomic ratio increases and also a flat reflectance, as low as 5%, can be observed in the films indexed to zone Ic.

CONCLUSIONS

The composition and structure of the films are strongly dependent of the target condition and deposition characteristics. It was found that the three systems have distinct electrical and optical responses opening the possibility to tailor the properties of the AlN_xO_y from those of the correspondent binary systems, according to the application envisaged. The properties of the ternary system can be explained assuming that the films (zone Ic) are in fact a percolation network of aluminium nanoparticles embedded in an oxide/nitride matrix. The aluminium grains can form irregularly shaped clusters with different sizes through the matrix, inducing a broadband absorption nearly independent of the wavelength. The conductivity is also governed by the constrictions between grains that can be in contact or separated by insulating barriers (oxide/nitride and/or voids). The barrier component of the films resistance has a negative dependence on the temperature and thus explaining the negative TCR for some films.

Acknowledgements: This research is partially sponsored by FEDER funds through the program COMPETE-*Programa Operacional Factores de Competitividade* and by national funds through FCT-*Fundação para a Ciência e a Tecnologia*, under the projects PTDC/CTM-NAN/112574/2009 and PEst-C-FIS/UI607/2011-2012.
One of us (J. Borges) is also indebted to FCT for financial support under PhD grant Nº SFRH/BD/47118/2008 (*financiada por POPH - QREN - Tipologia 4.1 - Formação Avançada, comparticipado pelo Fundo Social Europeu e por fundos nacionais do MCTES*).