N1s narrow spectrum study in AuN thin films

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Abstract. 3d and 4d transition metals has not been considered to produce nitrides. In the last years different paper has been shown with the synthesis and characterization of the AuN. Amount of nitrogen concentration into gold lattice is the discussion nowadays, because obtain of gold nitride phases would carry to find application to this material. In this work, gold thin films has been produced by varying the nitrogen concentration at discharge moment, because it is known that mean free path make that particles obtain different energies, leading to have different components in the surface of the thin film. N1s narrow spectrum shown gold nitride, oxynitride and carbonitride into gold surface.

1. Introduction

Plasma Assisted Systems (PAS) can produce thin films of noble metals nitride, due to progress in materials science and vacuum technologies; these films are obtained with different components, new chemical and physics properties that it does not possess the noble metal for itself [1,2]. AuN, PtN, IrN, OsN or PdN has been synthesized in the last decade generating researches about their crystalline structure, elastic stability and electronic structure [3,4]. Arc Pulsed, Reactive Ion Sputtering, Ionic Implantation and Laser Ablation techniques has been used to produce AuN [5-8], N1s narrow spectrum has been used to show the hybridization of nitrogen with gold [9,10] and Diffraction Patterns to show how nitrogen atoms are found in interstitial sites on gold lattice [11], because the nitrogen concentration has not been good to observer the gold nitride structure, this fact entail to necessity to made experimental that entail then to improving the nitrogen into gold thin films to can find possible applications to nitride.

In this work used the Mean Free Path (MFP) to increase the nitrogen concentration on gold surface. It was obtained gold thin films with compound different nitrogen (oxynitrides, carbonitrides and gold nitrides), the which are validated through N1s narrow spectrum. The gold thin films were obtained in an Arc Pulsed System, it varying nitrogen pressure at moment of the discharge.

2. Experimental set up

Arc Pulsed System non-commercial was used to produce the thin films (Plasma Physics Laboratory-UNAL Manizales-Colombia) [12]. The growth variables were: i) 3e arcs, ii) 200V discharge voltage, iii) 160ºC substrate temperature, i) 4mm interelectrode distance and the pression was varied (see Table 1).

| Sample | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
|--------|----|----|----|----|----|----|----|----|
| mmbar  | 2  | 3.5| 4  | 5  | 5.5| 6  | 7  | 7.5|

Table 1. Pression at discharge moment.
Gold target 99.999% and circular Stainless Steel were used as cathode and anode respectively. An XPS ThermoScientific ESCALAB 250 (Thermo Fisher Scientific Inc., Waltham, MA, USA) with AlKα (1486.6 eV) photoelectron energy was used for the chemical analysis, and the energy scale was calibrated for the C1s binding energy (284.6 eV) [13-16]. First, we obtained a scanning of 10 – 1200 eV (wide spectrum); then, the narrow spectra with 0.2 eV pass energy were collected.

3. Results and discussion
In the Figure 1, it is showed the Au narrow spectrum to S3, the which it is the same to each sample. It was not possible observer the presence of nitrogen on gold surface, because the spectral line was not possible its deconvolution.

![Figure 1. Au Narrow Spectrum.](image)

In the Figure 2(a), the nitrogen spectral line to S7 and S8 are showed, in these was not possible observe peaks, indicating the not presence of nitrogen in the surface, that it to say, it was obtained gold thin films. In the Figure 2(b), the nitrogen spectral line to S4, S5 and S6 samples is shown, it is possible observe small peak that corresponding to oxynitrides and carbonitrides [13]. In the Figure 2(c), the nitrogen spectral line to S1, S2 and S3 samples is shown, it is possible observe the increase of the nitrogen on gold surface, two peaks are found corresponding to oxynitrides/carbonitrides and gold nitride [9].

Different compound was found: oxynitrides (ONx), carbonitrides (CNx) and gold nitride (AuN), besides and samples that does not nitrogen. Through the MFP can be explained this phenomenon; at high pressures the atoms nitrogen loser its energy rapidly because the amount of particles in the plasma provoke collisions of short lengths compared to the length of the discharge, which entails to nitrogen atoms does not arrive on substrate Surface (see Figure 2(a)) [14]. In contrast at low pressures (< 6mnbar), where was possible observer the peaks in the N1s Narrow Spectrum, evidencing that nitrogen atoms it is arriving on the surface (see Figure 2(b) and 2(c)). Is known that the energy of particles at moment to arrive on surface allow that particles travell long away and can generate different compounds [15,16].
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Figure 2. (a) N1s narrow spectrum to S7 and S8, (b) N1s narrow spectrum to S4, S5 and S6 and (c) N1s narrow spectrum to S1, S2 and S3.

4. Conclusions
It was corroborated that Mean Free Path make that nitrogen atoms on the plasma obtain different energies to arrive on the surface substrate, the which entails that it is appearing different compounds in the gold thin films (oxynitrides, carbonitrides and gold nitride).

Acknowledgement
To Centro de Materiales de Nanociencia of the Universidad Industrial de Santander and the Laboratorio de Física del Plasma of the Universidad Nacional de Colombia.

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