Study by Spectroellipsometry of the InP Surface Evolution by Cerium Acidic Solution

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The accurate knowledge of the different mechanisms that rule the wet etching of semiconductors is an important problem as well for a fundamental purpose in semiconductor electrochemistry as for device technologies. The mechanisms (chemical or electrochemical), that are implied in the elementary steps, which made the global process, generate very complex interfacial chemical configuration for which it can be often difficult to collect unambiguous information. The optical technique can provide very efficient *in situ* probes to detect interfacial films. Among them spectroellipsometry can provide information about the kinetics of the surface transformation during the etching process as well as for its composition or the film thickness.
We will illustrate this point by using the study of the etching of the Indium Phosphide by Cerium acidic solutions [1].
The etching process is in fact rule by two electrochemical processes linked together. The initial one injects holes inside the BV during the reduction of the Ce^{4+} in Ce^{3+} (1). The holes are consumed by a classical anodic dissolution. This global mechanism (2) gives rise to an electroless process ruled by the diffusion into the solution which can be applied to a lot of semiconductors [2].

$$Ce^{4+} \rightarrow Ce^{3+} + h^{+} \qquad (1)$$
$$InP + 8h^{+} \rightarrow P^{5+} + In^{3+} \qquad (2)$$

On InP the process can give rise to a side reaction that for high cerium concentration decreases strongly the etching rate and sometimes stops the process. This perturbation in fact is associated to the growth of an interfacial film that blocks the injection of holes inside the BV. This film has a complex chemical composition, which is a mixture of a cerium phosphate (3) and InP oxides [3]. The structure of the film is an opened question, for example is it multilayer or monolayer nature?

$$Ce^{3+} + P^{5+} \rightarrow CePO_{4\ (precipitation)} \qquad (3)$$

In this paper we present an ellipsometric study of the growth of this film. Different steps of the surface blocking behaviour are analyzed by measurement of etching rate and film thickness, and by determination of film nature and composition. This will be compared to XPS data obtained on the same samples.

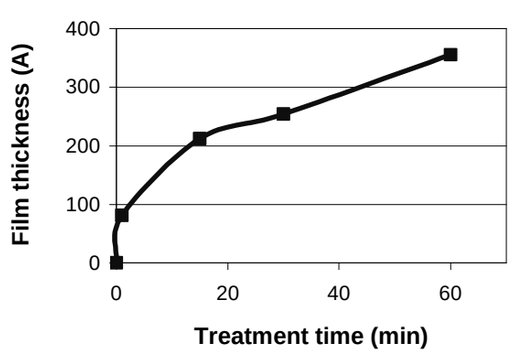

Figure : Film thickness (Å) in function of treatment time of InP surface by cerium acidic solution ($[Ce^{+IV}]=5.10^{-3}$ M, $[H_2SO_4]=0.5$ M).

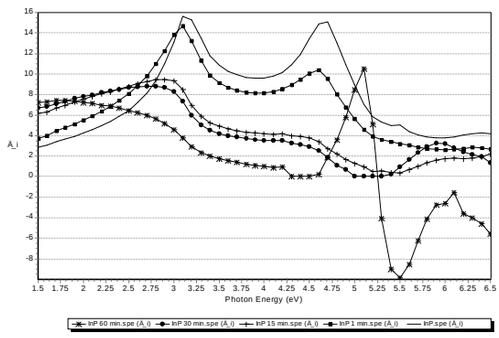

Figure 2: Evolution of ε_i in function of photon energy (same conditions as Fig. 1).

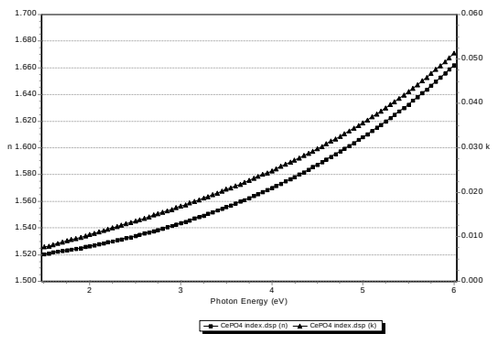

Figure 3: Evolution of n and k index in function of photon energy (same conditions as Fig. 1).

Data collected with Jobin Yvon UVISEL spectroscopic phase modulated ellipsomètre (wide spectral range from 190 to 830 nm).

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