Sol-gel synthesis and structural and optical characterization of pure ZnO nano powders doped with Aluminum(0.1, 0.5 ,0.75, 1, 5, 7,10,15 and 20%)

The first chapter is devoted to a general description of zinc oxide, in the first part, we are interested in a state of the art of its main properties such as its crystalline structure, its structure of electronic bands, its electrical characteristics. and optics. Then we go on to present the areas of zinc oxide applications (includes the results of a literature search). Finally we end this chapter with the study of doping according to the types and methods of doping.

Chapter 2 describes the development technique and the characterization methods used to carry out the thesis work.

The first part of This chapter discusses the deposition system used for the fabrication of zinc oxide (ZnO) nanostructures, in this case the Sol-gel technique. This method has the advantage of being simple. The second part deals with the different characterization methods used to analyze the structure, optical and electrical properties of zinc oxide (ZnO) nanostructures.

The synthesis of nanoparticles represents an important field in industry and arouses a lot of scientific curiosity. The applications cover a wide field such as construction (cement, plaster, hinge, etc.), fine chemicals (reagents, catalyst supports, catalysts, etc.) and medical (cosmetic products, dental dressings, prostheses, etc.).

Today, the scientific and technical stake lies in the development of nanoparticles, and in particular the control of their size and morphology.

In this chapter we mention some methods of elaboration of nanoparticles.

We will then detail the sol-gel process used in this thesis for the preparation of pure ZnO powders doped with aluminum.

Chapter 3 discusses the results of our work to develop and characterize pure and aluminum-doped zinc oxide nanopowders. The elaboration was done by soft chemistry, and the characterization used X-ray diffraction (XRD) to study the structural properties of pure and Al-doped nanopowders, scanning electron microscopy (SEM) to determine their morphology. and their microstructure, the infrared by Fourier transformation (IRTF) in order to determine various bonds present there and finally UV-visible spectroscopy for the study of optical properties.

We have focused our attention, in particular, on the interpretation of the effects of doping with Al2O3 and with AlCl3 on structural and optical properties, compared to those of undoped powders.

So the objective of this work focused on the development and study of the structural and optical properties as well as the morphology of ZnO nanopowders, starting from the fact that the decrease in the size of the grains, down to the nanometric scale , presents new physical properties and opens up promising prospects in terms of applications in various fields.

We also report the effect of doping and annealing temperatures on the structural and optical properties of ZnO synthesized using the chemical sol-gel method, which is inexpensive and easy to perform.

The aluminuim doping was carried out in two ways by adding $AlCl_3$ to the Zn solution by mixing the gel obtained with alumina before the receiving step. It was found that the two doping methods give very good results. sumelary.

The doping of the ZnO nanopowders with Al_2O_3 or else with $AlCl_3$ showed a certain decrease in the size of the grains with the concentration of the dopant, for both methods and a constant value. However, with a larger grain size for $AlCl_3$ doping powders.

The powders produced were analyzed by several techniques:

X-ray diffraction characterization showed that:

-the synthesized powders of ZnO, crystallize in a hexagonal würtzite structure.

-The grain size calculation has shown that it is of a nanometric order

-The scanning electron microscopy study showed that the appearance of the powders

two series is no different completely.

-The spectroscopic characterization by IR revealed all the links.

chemicals existing in pure and doped ZnO nanpowders, these bonds are similar for the two series, one will note in particular the bonds of Zn-O, one also observed the bonds hydroxide and carbon monoxide, these last two are due to the conditions of preparation. Confirmation of what was found by DRX should be retained from these results.

The UV-Vis analysis made it possible to highlight the high transparency of

suspended solutions of our powders in the ultraviolet and visible fields.

-The calculation of the energy of the gap Eg, using the method of the 2nd derivative and the method of extrapolation, We first observe a strong increase in the forbidden band, between 0 and 1% at t Al. forbidden then stabilizes and begins to decrease for concentrations greater than 7% Al, which coincides with the appearance of the spinel AlZn2O4phase on XRD diffractogram. No such tendency is observed during the annealing of the samples at 450 ° C. The increase in the forbidden band is easily explained by confinement effects induced by the reduction of the grain size associated with the Al doping. The point following the decrease in the band gap is attributed to the formation of the ZnO / ZnAl2O4 mixture. These results correlate very well with the XRD results.

at the end the optical gap values were determined in two ways, either by the extrapolation method, or by using the second derivative method. The two methods have been found to give very similar results.