International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-5 Issue-5, June 2016

A Simple Technique for Obtaining Better Porosity for Improved Performance of a Humidity Sensor

Arshi Salamat

Abstract: ***In this paper a method for obtaining better porosity is proposed .The sol gel method and anodisation of aluminium oxide together will result in formation of better pores on alumina. Better porosity will result in enhanced performance of a sensor.***

Keywords: porosity, sol gel, anodisation, adsorption

I. INTRODUCTION

The ability of alumina to sense humidity is based upon ionic conduction; the presence of an adsorbed layer of water at the surface reduces the total sensor impedance due to the increase in the ionic conductivity, as well as capacitance due to the large surface area available for water adsorption. Porous metal oxide (ceramic) based sensors do not change at increased temperatures and high humidity and have high sensitivity. Better porosity can be obtained using sol gel and iodization methods together.

II. EXPERIMENTAL WORK

A. Sol-Gel Method

The Sol gel process is very long known since the late 1800s .The versatility of the technique has been rediscovered in the early 1970s when glasses were produced without high temp melting processes.

Sol gel is a chemical solution process used to make ceramic and glass material in the form of thin films, fibres or powders.

Sol is a colloidal(the dispersed phase is so small that gravitational forces do not exist, only Vander waal's forces and surface charges are present) or molecular suspension of solid particles of ions in a solvent.(e.g. dust particles in air and water)

A gel is a semi rigid mass that forms when the solvent from the sol begins to evaporate and particles or ions left behind begin to join together in a continuous network.

Porous metal oxide Al2O3 sol is prepared using following steps of sol gel process.

Step 1: Hydrolyzing the mixture solution of Aluminium butoxide in excess amount of water under vigorous stirring on magnetic hot plate stirrer at 90 deg c.

Step 2: HCl is used as peptizing agent and solution is continuously stirred at 80 deg c

Step 3: The ratio of HCl and sol is optimized (adding HCL drop wise). The hydroxide molecule gets ionized by HCl solution and gets dispersed into nano sized molecule in the resulting solution. On complete peptization the solution becomes almost transparent.

Step 4: After 18 hrs of refluxing (removal of impurities), Polyvinyl Alcohol (PVA) is added which works as binder, under continuous stirring. This continuous stirring on hot magnetic plate not only removes the excess impurities but also makes the particle size uniform.

Step 5: The viscosity, pH value and the total volume of solution are kept fixed by adding water as required.

The sol gel approach is interesting that it is cheap and low temperature technique. This technique can produce thin bond coating to provide excellent adhesion between the metallic substrate and the top coat. It can produce thick coating to provide corrosion protection performance. It can provide a simple, economic and effective method to produce high quality coatings.

B. Anodisation

Anodizing was first used on an industrial scale in 1923 to protect seaplane parts from corrosion. Aluminium alloys are anodized to increase corrosion resistant, to increase surface hardness and to allow dyeing and improved adhesion. Anodised aluminium can be found on mp3 players, flashlights, cookware cameras, electrolytic capacitors. The porous oxides used for humidity sensing purpose. The structure of porous alumina prepared by this method can be influenced by technological parameters such as concentration and temperature of the electrolyte and the current density (or voltage) in the anodising cell.

AAO films are mostly fabricated by anodization of Al sheets of a few hundred micrometer thickness. There are reports where nanoporous alumina films are fabricated by anodization of evaporated or sputtered Al thin films on various substrates.

A well established method for porous Al_2O_3 preparation is the electrochemical oxidation of Al films under anodic bias. The quality of this layer and consequently the sensor's behaviour strongly depends on the thickness of the porous layer and the density and size of the pores as well. The structure of porous alumina prepared by this method can be influenced by technological parameters such as concentration and temperature of the electrolyte and the current density (or voltage) in the anodising cell.

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Manuscript published on 30 June 2016.
***** Correspondence Author (s)
Mrs. Arshi Salamat, Assistant Professor, Department of Electrical Engineering Section**,** University Polytechnic**,** Jamia Millia Islamia University, Jamia Nagar**,** New Delhi- 110025, India.

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Anodizing is an electrochemical process that converts the metal surface into a decorative durable corrosion resistant, anodic oxide finish.

Aluminium is ideally suited to anodizing, although other nonferrous metals such as Mg, Ti, Sn, also can be anodized. The anodised layer is porous. The process is called anodising because the part to be treated forms the anode electrode of an electrical ckt Alumina films are formed by anodising aluminium thick films protected on the back side by an adhesive layer. The anodization technique creates self-organised alumina pore arrays from the aluminium starting material. Adhesive backed Aluminium tape is used for anodization. A platinum electrode serves as cathode. The electrodes are separated by distance of 2cm

The Al is anodized in sulphuric acid solution in a single step. The anodic current density is kept at a constant value. The aluminium thin film is contacted with a metal clip which is not immersed in electrolyte. This way, the current flow stopped suddenly when the aluminium became completely oxidized, because there is no electrode left in the electrolyte to maintain electric field. Time to complete this process depends upon the thickness of aluminium layer.

III. CONCLUSION

There are reports in which a sol-gel coating is deposited on top of the anodized layer to render barrier properties. There are reports where initially, a purely inorganic sol-gel coating is deposited on the aluminium substrate, followed by heat treatment a high temperature (300 -500 deg c) for densification and then substrate is subsequently anodized.

In this way cumulative benefits of both processes are obtained [both sol gel and anodization].

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