Research Journal of Chemical Sciences E-ISSN 2231-606X
Vol. 6(12), 59-61, December (2016) *Res. J. Chem. Sci.*

Short Review Paper

Chemical Synthesis and Characterization of Aluminium doped Zinc Oxide (AZO) Nanocomposites - A Review

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Available online at: www.isca.in, www.isca.me
Received 22nd March 2016, revised 28th November 2016, accepted 7th December 2016

Abstract

Aluminium-doped zinc oxide (AZO) nanoparticles can be called a multifunctional material because of its unique physical and chemical properties. The present review broadly divided in to three main sections, namely introduction, literature survey and selection of problem followed by methodology. The introduction of review comprises summary of physical properties and its importance for modern application. Whereas, literature survey section gives idea about various routes for preparation of AZO nanoparticles. By analysing some recent report in literature, we will plane to synthesize AZO nanoparticles by co-precipitation method at low temperature.

Keywords: Zinc Oxide, Aluminium doped Zinc Oxide (AZO), Co-precipitation method.

Introduction

The highly transparent electrodes (TCE) which offer a low resistance has great important for flat-panel display and touch-panel screen industries, and also use for different filed of applications[1]. Transparent conductive oxides are in the form of thin film which conduct electricity and also transparent to visible light. Day by day there is increasing in demands for flat panel display, solar cell, and liquid crystal displays. So we require an inexpensive transparent conducting material. ITO is used as TCO but cost of indium is high so we require such type of a material which is affordable that is low in cost and comparable electrical and optical properties. AZO is best alternative to ITO. AZO can used as low cost TCO. One promising alternative to ITO includes random networks of aluminium doped zinc (AZO) materials. AZO materials provide lower sheet resistance and higher optical transmittance than other TCE candidates such as carbon nanotubes[2].

ZnO is also an alternative TCO because cost is low and also affordable; it is non-toxic, low cost. ZnO can be used as a conducting electrode material because it offers high resistance[3]. When ZnO is doped with impurities its conductivity increases. Another way is to use ZnO doped aluminium sandwich-like structures such as those shown in Figure-1.

The insertion of an lowest resistivity ultrathin aluminium can decrease the sheet resistance, while the aluminium are doped as thin films can be able to transmit visible light[4]. Aluminium in ZnO offer a high electrical conductivity as shown in Figure-1.

Review of Literature

Cho *et al.*[5] reported that the synthesis of Al-doped ZnO (AZO) nano needles and zinc aluminium hydroxides by using a seed layer. The 10 nm AZO nano needles and hexagonal zinc aluminium hydroxide wire synthesis and separated in one step an aqueous solution which contain metal ions was immersed was irradiate with microwave. AZO grew on substrate where, zinc aluminium layered double hydroxides grow in the bulk solution as shown in Figure-2.

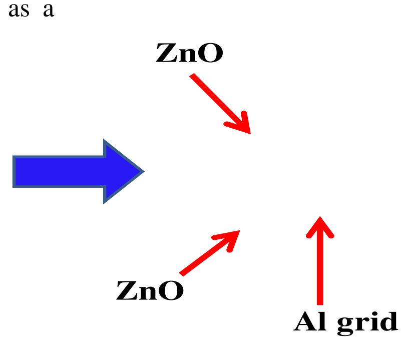

Figure-1
ZnO doped aluminium sandwich-like structures as transparent conducting electrode

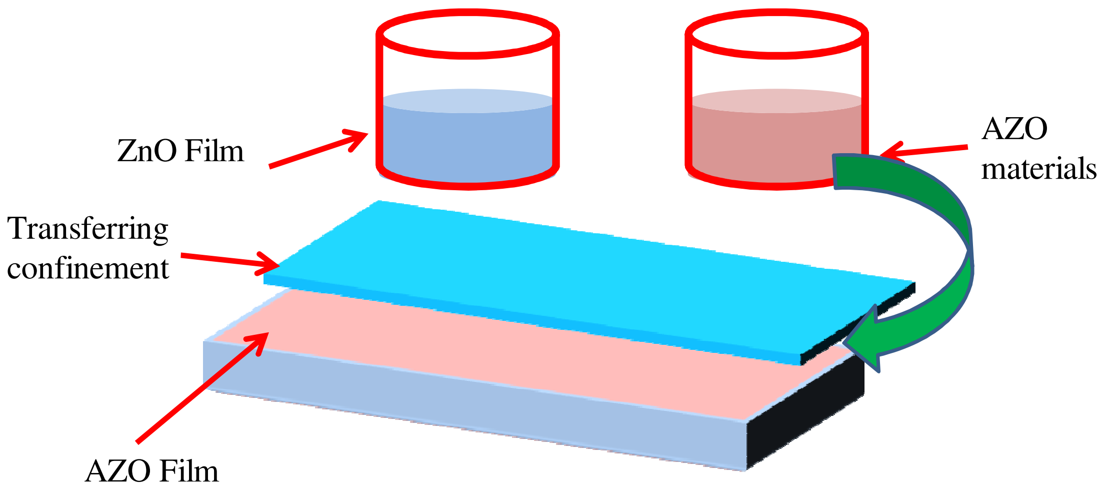

Figure-2
One step an aqueous solution which contain zinc doped aluminium

The length of AZO needles is 1.3 um. This method is the incorporate a specific area by using seed layer into solution. Hartner *et al.*[6] use chemical vapour technique for the synthesis of aluminium doped zinc oxide nanoparticle and study its electrical properties. In their study shows that under hydrogen and synthetic air ranges between 323 and 673k the impedance of dopant atom can be measure. The advantage of this synthesis is that under high temperature, high percentage of Al can be doped and high production rates can be achieved we do not require to remove organic components after synthesis the particle size decrease and area size will increase.

Hou *et al.*[7] found that atomic layer deposition is the effective method for the preparation of AZO film and also found that it has good electrical and optical properties. By using water and diethlyzinc trimethylaluminium the minimum resistivity of doped ZnO film is 2.4×10^{-3} ohm-cm at lowest Al-concentration. For selection of crystallization of ZnO phases thickness of ZnO sublayer is important. Hiromitkozuka *et al.*[8] studied that the preparation of sol-gel for transparent and conductive AZO films with highly superior crystal orientation. ZnO films were prepared by using sol-gel method on silica glass substrate from 2-methoxyethanol solution of zinc acetate and aluminium chloride that contained monoethanolamine, the coating were conduct at room temperature. The speed, heat treatment condition affect the resistivity the lowest resistivity is 0.5 at % aluminium. Park *et al.*[9] used RF magnetron sputtering technique for the preparation of AZO film. AZO film are prepared by RF magnetron sputtering on glass and Si substrates with ZnO target containing different amounts of Al_2O_3 powder substrate, working pressure investigate AZO film physical properties. AZO film is degenerate semiconductor with direct bandgap. For undoped ZnO film the optical energy band gap is 3.3eV. Lupan *et al.*[10] synthesized that the nanostructure AZO on Si for solar cell applications. The variations occur in doping concentration morphological and structural, electrical and optical properties should studied. The chemically deposited AZO thin film has wide applications of low cost solar cells in hetrojunction structure. The advantage of thin technology simplicity is energy saving short duration, auxiliary metal and high efficiency.

Zhang *et al.*[11] used hydrothermal method for the preparation and characterization of sol-gel AZO film and ZnO nanowire grown-up on AZO seed layer. The microstructural, electrical and optical properties of AZO thin films are affected by using sol-gel technique. AZO crystalline thin film is highly preferred co-axis orientation perpendicular to substrate is grown. Concentration of Al-doped is upto 1%. ZnO nanowire having large surface area generated on sol-gel which derived AZO thin film which can act as seed layer. Venkatachalam *et al.*[12] in 2008 used PLD technique for the preparation and characterization of Al doped ZnO thin films. By using this technique it is found that there is an effect on the composition surface morphology, optical structural and electrical properties of Al-doped ZnO thin film. It is observed that the crystalline nature of deposited film is inversely proportional to the Al-doping from 1% to 6%. The measurement of electrical property of deposited film depend on doping concentration and showed that values of hall mobility is in range between 2.51 and 10.64 cm^2/vs and carrier concentration between 15.7 and 0.78×10^{17} and resistivity values between 1.59 and 10.97 Ω·m . Agura *et al.*[13] studied that the low resistivity transparent conducting AZO film prepared by pulsed layer deposition by using PLD method grown on glass substrate. At substrate temperature of 230 °C the film deposition takes place within magnetic field which is perpendicular to the plume. To restrain the droplet group which caused by intense laser energy. The energy density lowered 280 nm thick and AZO film grown-up at a target to 88% in visible range. Sahey *et al.*[14] reported that the AZO thin films for petroleum gas sensor. AZO thin film were prepared by using chemical spray pyrolysis technique in which using zinc nitrate can be used as precursor solution without or with $AlCl_3$ as a doping solution. The dopant concentration was varied from 0 to 1.5. The film show change in prefential orientation depending on the doping concentration of aluminium. With the Al-dopant concentration the resistivity of AZO films were reduced. Al-doped ZnO film show high response to LPG at higher doping.

Martin *et al.*[15] fabricated the AZO film by ECR plasma enhanced CVD. Plasma enhance CVD is conductive AZO films is deposited by reaction of zinc nitrate and aluminium nitrate with mixture of hydrogen and oxygen plasma obtained by ESR downgrade plasma source operated at low amount in the film. At room temperature optical constant was determined by conduction by four point probe. The lowest resistivity was obtained for sample prepared with plasma of $h2+0_2$. Jood *et al.*[16] reported that the AZO nanocomposite with enhanced thermoelectric properties. Due to high electrical conductivity ZnO has high figure of merits. Thermoelectric materials are power harvesting due to its high melting point, higher electrical conductivity and seebeck coefficient.

Conclusion

The highly transparent electrodes (TCE) offer a low resistance and widely use for flat-panel display and touch-panel screen industries, and also use for different filed of applications. ITO is expensive due the reducing the availability of indium and its environmental chemical stability is also limited, which can lead to device corrosion over time, and ITO is quite brittle. Hence, AZO materials are promising candidate for TCE due to its low toxicity, low cost approach and synthesis methods. Therefore, AZO is best alternative to ITO. The present review, gives systematic report of AZO materials as transparent conducting electrode for different applications.

Acknowledgement

Authors are very much thankful to Head, Department of Physics, Sant Gadge Baba Amravati University, Amravati, India.

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