

Feasibility Study of New Techniques: Spray Pyrolysis Simulation

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Abstract-Conducting oxide thin films previously manufactured by electron evaporation techniques. Structural, optical as well as electrical qualities had been analyzed below diverse preparation problems just like substrate heat range, alternative stream rate as well as rate associated with deposit. Resistivity associated with undoped evaporated films diverse coming from $2.60 \times 10^{-2} \Omega\text{-cm}$ and $3.46 \times 10^{-3} \Omega\text{-cm}$ inside the heat range assortment 140–180°C. Pertaining to undoped spray pyrolyzed films, resistivity had been witnessed to stay the product range 1.3×10^{-1} to $1.60 \times 10^{-2} \Omega\text{-cm}$ inside the heat range assortment 200–350°C. Impact sizes indicated how the flexibility as well as concentration associated with evaporated films had been over in which associated with spray put into the accounted films. The best resistivity pertaining to antimony doped tin oxide film had been observed to become $7.70 \times 10^{-3} \Omega\text{-cm}$, that was put into the account at 300°C along with 0.25 grams associated with SbCl_3 as well as few grams associated with SnCl_4 ($\text{SbCl}_3/\text{SnCl}_4 = 0.063$).

1. INTRODUCTION

Container oxide lean films are n-type semiconductors with excessive visibility and very good power conductivity. The particular films are chemically inert, mechanically hard and may with resistance property. As a result of the minimal resistivity and also excessive transmittance, oxide lean films are employed to be a windowpane covering within solar panels (Frank et ing 1983; Goetzberger and also Hebling 2000), warmth reflectors within solar panels (Colen 1981), numerous fuel devices (Nomura et 1989; Brinzari et 2001), for example. Doped or even undoped oxide films is usually prepared by many strategies including aerosol pyrolysis (Kulaszewicz 1980; Kulaszewicz et 1983; Fantini 1986; Ansari et 1997), electron column evaporation (Das and also Banerjee 1987; Lousa et 1994), chemical substance vapour deposit (Lou et 1983), magnetron sputtering (Minami et 1988), Pechini method (Bernarti et 2002).

Squirt pyrolysis is among the most straightforward types of lodging translucent conducting oxide films including ZnO (Van Heerden and also Swanepoel 1997), CdO (Rao and also Murthy 1999) for example. On this method the actual substrate temperatures and also price adjustments is one of the most desired optical, structural and also power involving oxide films. Shanthi et (1980) ready oxide films simply by aerosol pyrolysis and also claimed a utility resistivity involving $2.5 \times 10^{-2} \Omega\text{-cm}$ at $T_s = 300^\circ\text{C}$. Identical film that has been annealed within vacuum at 350°C confirmed the lowest resistivity of just $1 \times 10^{-2} \Omega\text{-cm}$ and also films annealed within fresh air confirmed higher resistivity involving about $9 \times 10^{-2} \Omega\text{-cm}$.

Antimony doped container oxide films show some sort of least resistivity benefit of $1.10 \times 10^{-3} \Omega\text{-cm}$ deposited with 1.5 mol% antimony. Jagadish et al (1988) researched the optical as well as electric attributes of spray deposited films as well as claimed how the page resistance of oxide films can be reduced by means of annealing all of them throughout hydrogen

ambiance beneath 300°C pertaining to 30 minute. When compared with garaju (2002) organized antimony doped container oxide films coming from SnCl_2 precursor as well as obtained a decreased resistance of $6.1 \Omega/\text{E}$ for a doping attention of $(\text{SbCl}_3)/(\text{SnCl}_4) = 0.5 \text{ wt\%}$. Jarzebski (1982) reviewed physical attributes of SnO_2 films served by various strategies.

Oxide films ended up in addition served by thermal ray evaporation exactly where stoichiometry adjustments electric as well as optical attributes of the films. Very clear as well as executing films can be developed by evaporating the material (99.99%) from the occurrence of air. Das as well as Banerjee (1987) organized oxide films by means of this technique throughout occurrence of air as well as acquired electric conductivity of $4.6 \times 100 \text{ } \Omega\text{-cm}$ as well as an average transmitting of 80%.

Lousa et al (1994) organized container oxide films by means of reactive evaporation technique as well as claimed how the substrate heat $> 400^\circ\text{C}$ as well as the air partial demand $> 4 \times 10^{-1}$ pascal can easily generate polycrystalline films. They've already in addition claimed the excessive electric conductivity (s) of the obtain of $100 \text{ } \Omega\text{-cm}$ pertaining to films deposited on about 450°C by having an air partial demand of 3×10^{-1} to 5×10^{-1} pascal.

2. EXPERIMENTAL

2.1 Electron beam evaporation

Tin oxide films were geared up in a very regular evaporation system through electron column evaporation on the steel tin (98.98%) from the reputation regarding each simple in addition to ionized O_2 with a force regarding 2×10^{-4} m pub and a launch existing regarding 250 milli amps has been applied. Self-made launch conduit has been applied to obtain the ionized O_2 . The particular substrates were warmed up along with the heat has been calculated by using a thermocouple, that is in touch with the substrate case in

addition to has been varied between 50°C to 200°C. The particular film depths along with the fee regarding depositing were handled by using a quartz crystal keeps track of. The particular fee regarding depositing on the films has been varied between 1 in addition to 3 Å/s. The particular depth on the films has been calculated by using a spectrophotometer from the interference highs.

2.2 Spray pyrolysis

Spray pyrolysis build applied in the present do the job will be spelled out anywhere else (Rao and Murthy 1999). It is just a chemical substance depositing strategy in which the endothermic winter decomposition comes about in the warm area on the substrate to give more effect. The particular substrate heat plays a crucial part to form the film. Once the substrate heat will be under 200°C, the spray slipping for the substrate will certainly endure incomplete decomposition (oxidation) supplying increase into a foggy film which is with transparency and also electric power conductivity will probably be inadequate. In the event the substrate heat will be too much (> 500°C) the spray becomes vaporized previous to accomplishing the substrate along with the film will become almost powdery. Although on the best substrate heat from the choice of 250°C -450°C the spray reaches the substrate area from the somewhat fumes point out in addition to total oxidation will take place to provide apparent SnO₂ film to be a last merchandise seeing that observed in our own studies.

It is just a straightforward in addition to affordable approach to organizing translucent in addition to conducting oxide films regarding homogeneous depth and with electric powered in addition to optical components that could be comparable having machined placed films. An additional specialty of the process will be, through the option stream by way of provider fuel force you possibly can boost optical in addition to electric powered components on the films.

Undoped tin oxide films were placed upon glass in addition to quartz substrates on distinct temps (200°C to 300°C) by using a resultant option regarding tin tetra chloride (SnCl₄) wiped out throughout ethanol regarding identified attentiveness (0.1 M and to 0.2 M). So that you can prepare the antimony doped tin oxide films, identified pounds regarding SbCl₃ (0.10 to 0.60 g) has been put into 5 gm regarding SnCl₄ using a handful of drops regarding concentrated HCl along with the concoction has been wiped out throughout 100 ml regarding ethanol. The most effective stream fee (5 ml/min) has been handled through provider fuel force (0.5 kg/cm²).

Optical transmission scientific studies of all films served by both the techniques were created by using a Hitachi UV, noticeable in addition to near IR dual column spectrophotometer (Model No. 330). The particular framework on the film shas been examined through X-ray diffraction (XRD) making use of CuK α radiation. Encoding electron microscope (SEM) in addition to EDAX were employed for morphology in addition to chemical substance examination on the films. The particular electric powered components were

examined through Vehicle der Pauw resistivity process in addition to Area coefficient process (Schroder 1990).

3. RESULTS AND DISCUSSION

3.1 Optical properties

Evaporated oxide films transferred on 100°C along with oxygen had been located to become a smaller amount see-through in the apparent place. Nevertheless, the particular films transferred along with ionized oxygen on Ts = 100°C - 200°C had been highly see-through (90%).

Statistics 1 (a)-(b) present the particular indication spectra involving evaporated container oxide films transferred on unique substrate temperature ranges along with ionized breathable oxygen. On the indication spectra, optical parameters such as intake coefficient (a), refractive catalog (n) and optical music group distance, have been considered.

The particular intake coefficient on quicker wavelengths ended up being decided from the spectrophotometer blood pressure measurements when using the regards:

(a) = (2.303/d) log₁₀ (1-R)/T, where by 'd' will be the width with the film with cm, Capital 'T' and 'R' be classified as the transmittance and reflectance with the film. For the usual evaporated film transferred at the substrate heat range involving 200°C, (a) vs vitality graph can be plotted and simply by extrapolating the particular right series, that was created to slice the power axis at the a = 0 as well as the similar optical vitality music group distance is located to become all-around 3.68 eV when using the Swanepoel (1983) process. The particular refractive catalog on this film ended up being worked out via indication data and yes it ended up being located to become all-around 1.88 at the wavelength involving 500 nm (figure 3 (a)). Most of these beliefs come in good contract with the reported beliefs (Das and Banerjee 1987).

3.2 Electrical properties

Power parameters similar to sheet level of resistance (Rs), resistivity (r), carrier attentiveness (n) and flexibility (m) involving oxide films had been measured at area heat applying Van der Pauw resistivity approach and Corridor influence dimension by making use of a new magnetic field involving 3 to 4 k gauss (1 k gauss = 0 \times 1 Tesla). Level of resistance involving films prepared at ambient heat along with natural breathable oxygen had been identified to get most of the buy involving 105 Ω / ϵ whereas lodged films along with ionized oxygen at Ts starting from 50°C -200°C had been identified to get remarkably completing and see-through. It turned out furthermore noticed which the films prepared at higher substrate heat > 250°C with higher price involving deposition (2 Å/s) display reduced level of resistance. An average film lodged at 250°C that has involving (2 Å/s) incorporates a sheet level of resistance involving 453 Ω /m. Antimony doped (5 wt%) oxide films made by evaporation process in a substrate heat involving 100°C showed a new

sharp improvement from the level of resistance and it had been identified to get around 15 k Ω . Although the film lodged at higher substrate heat involving 200°C along with identical percent involving antimony incorporates a low level of resistance involving 7.5 k Ω which in turn indicates that substrate heat plays a significant role within enhancing electro-mechanical attributes from the films. It could be witnessed in the previously mentioned effects which the antimony doped (5 wt%) jar oxide films prepared at 200°C demonstrated higher level of resistance (7.5 k Ω) compared to undoped films (453 Ω /m) at the identical heat.

Kulaszewicz (1980) examined the issue regarding antimony dopant within fuel cell oxide films about the electrical conductivity along with reached the top conductivity if the dopant is within range regarding 0.01 to 0.02 (g Sb) (g Sn)-1. For this reason we are able to help the conductivity of the films through doping a ideal percentage regarding antimony.

4. CONCLUSIONS

Fuel cell oxide films had been made by electron beam evaporation and also apply pyrolysis strategies. Optical, structural and also electric powered attributes these films had been examined to be a functionality of substrate temperatures, depositing rate, molarity from the solution and also doping proportion of antimony. This band gap of evaporated film was in range of 3.60 to 3.70 eV which of apply put into the films was in range of 3.56 to 3.62 eV. Refractive indices had been 1.70 and 2.40 with a wavelength of 300 nm for evaporated and also apply into the fuel cell films, respectively. Resistivity of undoped evaporated oxide fuel cell films had been less than the other films. Antimony doped spray into the films show a sharp reduction in resistivity. This ideal doping concentration of antimony with oxide films has been discovered to become (SbCl₃/SnCl₄) = 0.050 giving the cheapest resistivity of 5.64 × 10⁻⁴ Ω -cm.

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