

RESEARCH ARTICLE

PREPARATION OF POLY (METHYL METHACRYLATE) THIN FILMS BY SPIN COATING TECHNIQUE FOR OTFT AND WOUND HEALING APPLICATIONS

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ABSTRACT

Thin films of poly (methyl methacrylate) (PMMA) were prepared on cleaned glass slides by using spin coating technique. The prepared films were identified by using FTIR spectrum. Surface morphology of the coated films was studied by using SEM and AFM. Both as grown and annealed films showed smooth and amorphous structure. It also revealed the absence of pits, pin holes and dendritic features in the surface. Both as grown and annealed films showed very low RMS roughness value. The morphology analysis revealed that the prepared film could be used as dielectric layer in thin film transistors and as drug delivery system for wound healing.

Keywords: PMMA, Morphology, Roughness, Spin coating.

1. INTRODUCTION

Poly(methyl methacrylate) (PMMA) is one of the promising polymers and there are numerous proposals for its application as dielectric in organic thin film transistors (OTFTs)[1-2], as optical lenses in camera and optical fiber [3-6]. Due to its excellent bio- and hemocompatibility and ease of manipulation, it is used in many medical devices, including blood pumps and dialyzers. Its optical properties make it a candidate material for implantable ocular lenses and hard contact lenses. It is a non-metallic implant material in orthopaedics and it is also used in denture fabrication, *in situ* drug delivery system for antibiotics in cavities produced by osteomyelitis. It has also been proposed as a drug delivery system for anti-blastic drugs in the *in situ* therapy of tumours affecting the bone and a new application of PMMA comes from spinal surgery. With the technique of vertebroplasty, a crushed vertebral body can be restored to its original volume and its inner space can be filled with PMMA cement to assure mechanical strength. Though lot of work has been reported on the preparation and characterization of PMMA thin films, to the best of our knowledge, there is no report on the nanoscale thick PMMA films prepared by spin coating method. In the present work an attempt has been made to prepare nanoscale PMMA thin films by spin coating technique and to study their surface morphology using SEM and AFM in order to find out the feasibility of using these thin films as dielectric in OTFTs and in wound healing applications.

2. EXPERIMENTAL

Conventional PMMA obtained from Sigma-Aldrich was used without further purification to prepare PMMA thin films. Anisole was used as a solvent to dissolve PMMA. The solution was spun on cleaned glass slides at room temperature to prepare PMMA thin films. After spin coating process, the samples were dried in the vacuum chamber to evaporate the solvent remained in the film. The films were annealed in Ar ambient. The PMMA films coated were identified by using a FTIR spectrometer (NICOLET 6700 FT-IR). The surface morphologies of the as grown and annealed PMMA films were investigated by means of SEM (FEI company, XL-305) and TM-AFM (Digital Instrument, Nanoscope IIIa).

3. RESULTS AND DISCUSSION

The FTIR spectrum of as grown PMMA thin film of 300 nm is shown in the Fig. 1

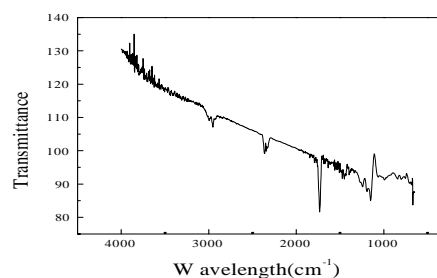
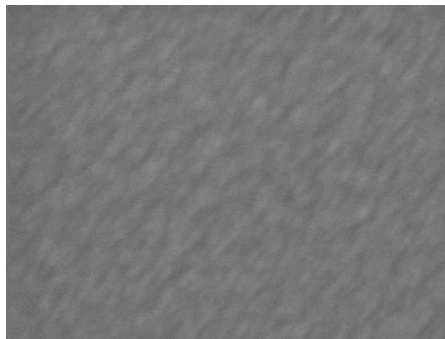


Fig.1 FTIR spectrum of PMMA thin film.

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The peak observed at 1150 cm^{-1} is assigned to C-O stretching (ester) where as the peaks observed at 1450 cm^{-1} and at 1740 cm^{-1} are assigned to O-CH₃ bending and C=O stretching respectively. Films subjected to various annealing temperatures ranging from 50°C to 200°C showed no changes in the FTIR spectrum (Figs not included).

Surface morphology of dielectric layer is very important because it affects the property of the semiconductor layer coated over it. Fig. 4a- d shows the SEM image of the PMMA films annealed at different temperatures. The film surface of as grown and films annealed at 100°C , 150°C and 200°C is compact. No pits, pin holes and dendritic features are found in the surface. Macroscopic granular chains appear at the surface in the stretching direction of PMMA film. The granular structures vary in size from few nanometers to hundreds of nanometers.



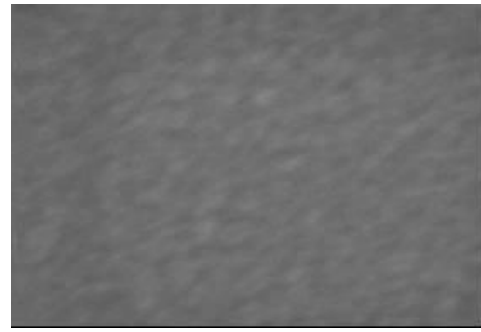
a) As deposited (x250000)



b) Annealed at 100°C



c) Annealed at 150°C



d) Annealed at 200°C

Fig. 4. SEM image of a) as grown, b) 100°C annealed, c) 150°C annealed and d) 200°C annealed samples.

The surface morphology of both as grown and annealed films is quite homogeneous and amorphous in nature.

Fig. 5 shows the atomic force micrographs of as grown and annealed PMMA films. Both as grown and annealed films exhibited random morphologies with smooth surface having micro-domains of less than 100 nm . The RMS roughness was found to be very low for as grown and annealed films.

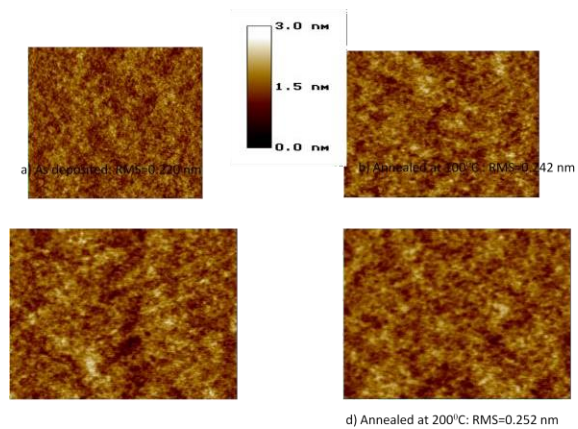


Fig. 5. AFM image of a) as grown, b) Annealed at 100°C , c) Annealed at 150°C and d) Annealed at 200°C .

The roughness increased a bit with annealing cycle. No pit, pin holes and dendritic feature are observed in the AFM topographical image of the samples studied. The only topographic features observed is the hillock of about $10 - 100\text{ nm}$ large and a peak to valley distance of about $0.5 - 1\text{ nm}$.

Annealing is a process related with stress relief and local structural rearrangement of polymer chains. It is observed from the AFM and SEM analysis that films annealed above 100°C showed very smooth surface, which is one of the most

important requirement of a dielectric layer in thin film transistors. As the annealing temperature increases, intrinsic changes in the microstructure of PMMA as well as in interface are expected. The evidence for the formation of rougher surface with annealing cycles is observed in the AFM spectrum (Fig.5). It is observed that the RMS roughness value increased with the increase of annealing temperature. As grown film showed a RMS roughness of 0.220 nm where as the film subjected to 200°C annealing showed a RMS roughness of 0.252 nm.

4. CONCLUSIONS

Nano scale thick PMMA thin films were prepared by simple spin coating technique. Surface morphology of the PMMA thin films have been studied by AFM and SEM. No pits and pin holes were found in the surface. Both as grown and annealed films showed smooth surface. The RMS roughness was found to be very low for as grown (0.220nm) and it increases a little with increase of annealing temperature. The observed thermal stability, amorphous and smooth surface and lower roughness values implies that thin films of PMMA formed by spin coating could be used as an efficient dielectric layer in organic thin film transistors (OTFTs) and as drug delivery system for wound healing.

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