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# Bio-Compatibility, Surface & Chemical Characterization of Glow Discharge Plasma modified ZnO Nanocomposite Polycarbonate

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**Abstract.** Bio compatibility is an important issue for synthesis of biomedical devices, which can be tested by bio-adoptability and creations of active site to enhance the bacterial/cell growth in biomedical devices. Hence a systematic study was carried out to characterize the effects of Nitrogen ion plasma for creations of active site in nano composite polymer membrane. Nano particles of ZnO are synthesized by chemical root, using solution casting nano composite polymeric membranes were prepared and treated with Nitrogen ion plasma. These membranes were characterized by different technique such as optical microscopy, SEM- Scanning electron microscope, optical transmittance, Fourier transform infrared spectroscopy. Then biocompatibility for membranes was tested by testing of bio-adoptability of membrane.

**Keywords:** Synthetic Membrane, Plasma Treatment, Plasma Etching, Bio compatibility, Bio adoptability, Active sites.
**PACS:** 52.77.Bn, 87.85.Xd, 87.85.jj, 87.16.dt.

## INTRODUCTION

Polymers are receiving grate interest in modern manufacturing processes as they can offers wide varieties of chemical and mechanical properties, as well as easy possibility of polymers makes them for suitable for synthesis of numerous bio-medical devices[1]. But bio compatibility is an important issue for synthesis of biomedical devices, which is a function of bio-adoptability and presence of active site to enhance the bacterial/cell growth in biomedical devices.

Also it is well known that permanent bonding, coating, printing, etc. are difficult on many polymers without surface pre-treatment. Therefore, after the surface treatment of polymers these have significant benefits in the specific requirements of surface properties, creations of active sites while retaining bulk mechanical properties unaffected. The physical and chemical surface modifications of polymeric materials without alteration of the bulk properties are of also great interest in many other applications [2, 3].The complex nature, presence of ions, neutrals and radiation in low-temperature plasmas make it widely useable in a growing number of materials fabrication processes including etching of complex patterns, surface modifications and creations of active sites.

In this paper a systematic study was carried out to characterize the effects of Nitrogen ion plasma for creations of active site in nano composite polymer membrane and then biocompatibility for membranes was tested by testing of bio-adoptability of membrane.

## EXPERIMENTAL

Polycarbonate granules were used to prepare flat sheet membranes by solution cast method. Dichloromethane of extra pure grade was used as a solvent for preparing membranes. Solution-casting method was used for preparation of nano composite polycarbonate membranes (doped 5%). Polycarbonate granules are weighed and dissolved in dichloromethane ($CH_2Cl_2$). Agitation of the solution is important, since the solvent penetration is very slow for high molecular weight polymers and a viscous coating is usually formed over each particle. The solution is stirred by magnetic stirrer to ensure the uniform dissolution and to enhance the rate of dissolution. The process is carried out at room temperature for around 2-3 hours till a clear solution is formed. The solution was then put into flat-bottomed Petri-dishes floating on mercury to ensure uniform membranes. The solvent was allowed to evaporate slowly over a period of 3-4 h. The films so obtained

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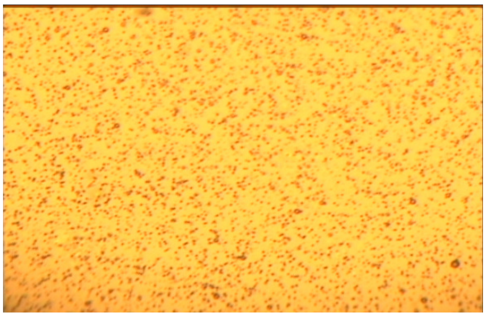
were peeled off using forceps. Air Plasma treatment was done for these membranes at $10^{-1}$ mb pressure. Air ions plasma was generated by using 1KV power supply with plasma current of 0.2 mA.

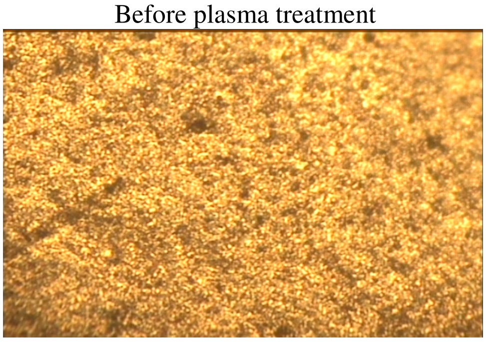
Bio adoptability of membranes was tested by natural cell membrane mechanism.

## RESULT AND DISCUSSION

20 µm Nano composite PC polymer membranes were synthesized and Nitrogen plasma treatment was done, with concentration of 5% ZnO nanoparticles and characterized before plasma treatment and after plasma to make comparative study.



Before plasma treatment



Plasma Treated

**FIGURE 1.** Optical micrograph of 5 % ZnO Casted PC membranes.

The FTIR spectrum (Fig 2) of nano composite membrane shows broad band with very low intensity at 3493 $cm^{-1}$ corresponding to the vibration mode of water OH group indicate the presence in small amount to be absorbed on the ZnO nanoparticles. A strong band at 500 $cm^{-1}$ attributed to the ZnO stretching band, while other absorption peaks shows basic structure of Polycarbonate (PC). No change in basic structure of PC has found before and after plasma treatment that shows that plasma treatment modified surface properties without alteration of the bulk properties (Fig 2). We also investigated the surface morphologies of Nano composite ZnO, polycarbonate membranes using SEM. The SEM images of films are shown in Fig. 3. Nano composite ZnO, polycarbonate membranes, the grain size distribution is quite homogeneous and plasma treatment improves its porosity.

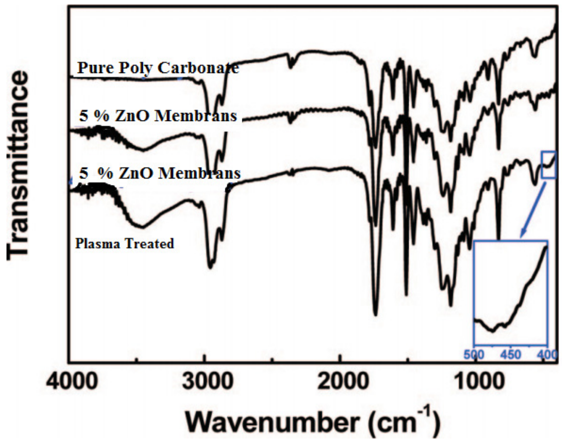
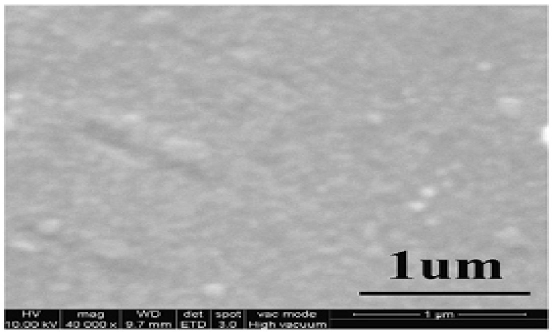
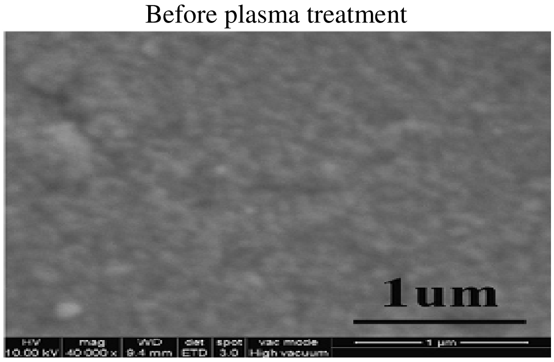



**FIGURE 2.** The FTIR spectra of ZnO nano composite polycarbonate membranes.




Before plasma treatment




After Plasma Treatment

**FIGURE 3.** SEM images -Nano composite ZnO (5 %).

Fig. 4 shows the optical transmittance in the wavelength range of 300–800 nm for Nano composite ZnO, polycarbonate membranes with/without the ZnO, using air as reference. In the visible range of 400–700 nm, the transmittance of the Nano composite ZnO, polycarbonate membranes is lower than that of the polycarbonate.

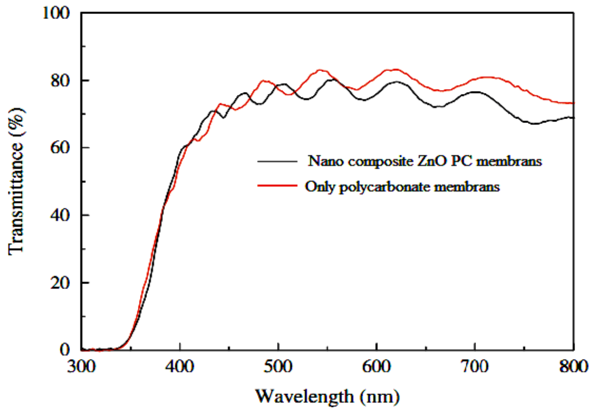



**FIGURE 4.** Optical transmittance spectra of Nano composite ZnO membranes and only PC.

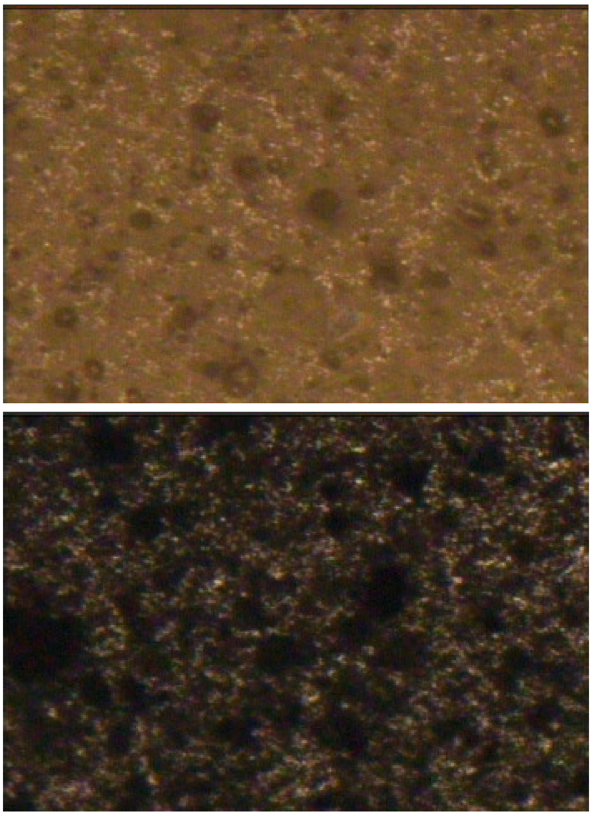


**FIGURE 5.** Bio-adoptability and creations of active site for selective bacterial growth in untreated and plasma treated Nano composite polymer membranes.

## Bio-Adoptability and Creations of Active Site for Selective Bacterial Growth

Bacteria growth on membrane, E.coli bacteria was chosen as it shows the clear colonies within 72 hrs. The autoclaved membrane was mounted on the liquid nutrient Agar (Autoclaved) media by streaking and spreading on membrane. The plates were kept at 37º C in the incubation chamber. The membranes were studied under optical microscope. In this study the media is supported with the polymer membrane of poly-carbonate of thickness 20 micron. For the nano composite polymer film without plasma treatment it is non-porous, this polymer film was acting as a passive layer between the base support and food (media). This results into no growth on the surface of polymer film. But for the nano composite polymer film which is made porous by plasma treatment a huge bacteria growth was observed due to creation of active sites for bacteria growth (Fig 5). Hence plasma treatment increase bio-adoptability of nanocomposite polymer hence makes them bio compatible.

## CONCLUSION

Characterization studies have shown that nanocomposite polycarbonate membranes do not have porosity, but after plasma treatments considerable improvement in surface morphology and porosity was found. An increase in surface roughness has been observed after plasma treatment. The creation of active sites and selective bacterial growth was observed on membrane by natural cell membrane mechanism that shows improvement in bio-compatibility of polymer membranes. This shows that plasma treatment is an efficient method for synthesis of biomedical devices.

## ACKNOWLEDGMENTS

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