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Positron Annihilation Lifetime Spectroscopy in Neutrons Irradiated CR39 Polymer

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Introduction

Positron Annihilation Spectroscopy (PAS) is considered as one of the powerful nuclear probe techniques where the angstrom size could be tracked [1]. The availability of PAS proved in the characterization of metals [2], semiconductors and polymers[3]. It is well demonstrated the success of using PAS to determine the free volumes (0.1-1 nm), voids(>1nm) and layer properties in polymeric system. Positron Annihilation Lifetime Spectroscopy (PALS) based on the measure of positron life time spanned inside matter. CR39is an amorphous polymer, sensitive to charged particles, gamma rays and neutrons. One of the known uses, is being as solid state nuclear track detector (SSNTD[4]. Actually, we can characterize the CR39 as an amorphous polymer using the free volume key (kind of defects existed in polymers) which has an important correlation with the macroscopic properties.

Experimental Study

CR39 samples have been irradiated with fast neutron at fluencies of 2.1×10^9, 4.1×10^9 and 15×10^9 n/cm^2. Then, The PALS measurements were carried out with a digitalpositron annihilation lifetime spectrometer. For each irradiated sample, an in-situ annealing treatment has been carried out during the PALS measurement taking the following values; 303, 323, 343, 363K.

Results and Discussion

The analyses of positron lifetime spectra shown increase of the ortho-Positronium component τ3 with increasing annealing temperature, T. Such an increase of τ3 has been related to a change in the size of latent tracks created via thebackscattered atoms, especially the protons. A linear behavior of τ3 has been found as it is clear in Fig A.

Conclusion

The effect of annealing temperature on the evolution ofthe ortho-Positronium lifetime, τ3, has been studied using positron annihilation lifetime spectroscopy. From the analysis of positron lifetime spectra, we observed an increase of τ3 with increasing annealing temperature. We think that this result can be used to predict the neutron fluencies in the case of CR39 irradiated with a fast neutron

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field.

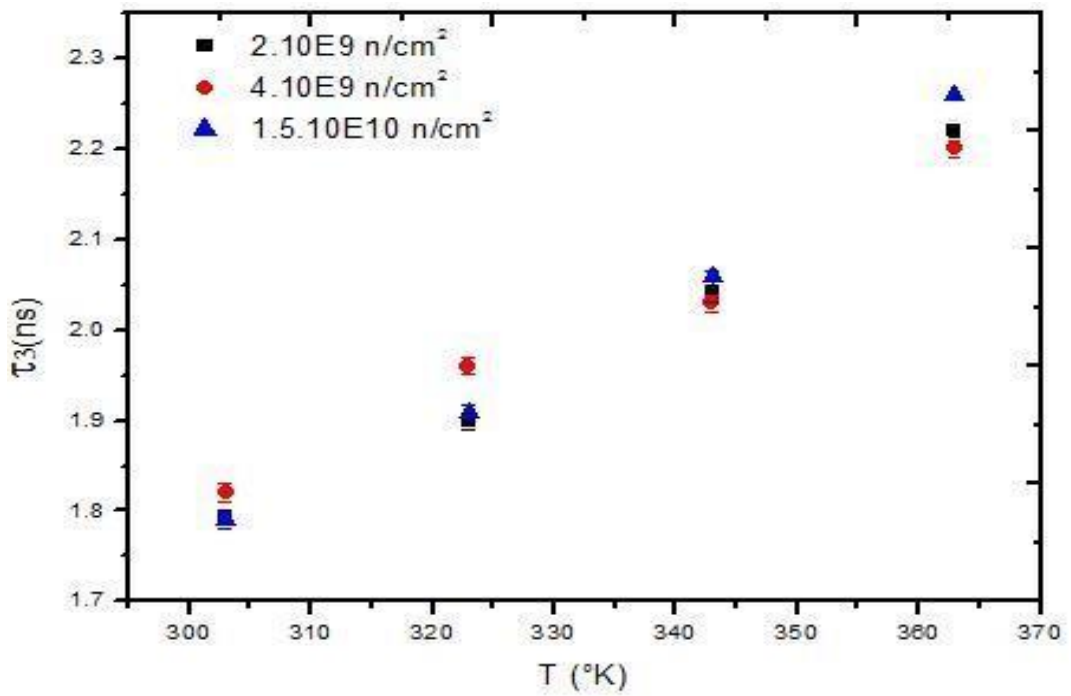

Fig. A Evolution of τ3(ns) versus in-situ annealingtemperature T(°K) for the irradiated samples.

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