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Field and Temperature Dependent Charge Transport Characteristics in Regio-regular Poly(3-octylthiophene-2,5-diyl) Studied by Muon Spin Relaxation

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Table of contents

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Preface

Papers

012014 Positron annihilation study of the hardening behavior in Al-Cu based alloy by electron and heavy ion irradiation Fuminobu Hori, Ippei Kobayashi, Yuichi Saito, Norito Ishikawa, Takeshi Oshima and Akihiro Iwase doi: 10.1088/1742-6596/225/1/012014 Tag this article Abstract References Full text PDF (560 KB)

012020 Free volume in Zr-based bulk glassy alloys studied by positron annihilation techniques A Ishii, A Iwase, Y Yokoyama, T J Konno, Y Kawasuso, A Yabu-uchi, M Maekawa and F Hori doi: 10.1088/1742-6596/225/1/012020 Tag this article Abstract References Full text PDF (383 KB)

012023 A positron beam study on vacancy formation in iron by ion beam irradiation at low temperature T Iwai, K Murakami, Y Katano, T Iwata, T Onitsuka and H Abe doi: 10.1088/1742-6596/225/1/012023 Tag this article Abstract References Full text PDF (607 KB)

012043 Study of Gadolinium-doped cerium oxide by XRD, TG-DTA, impedance analysis, and positron lifetime spectroscopy S Ohta, T Kosaka and K Sato doi: 10.1088/1742-6596/225/1/012043 Tag this article Abstract References Full text PDF (711 KB)

012035 Investigation of hydrogen interaction with defects in zirconia O Melikhova, J Kuriplach, J Čížek, I Procházka, G Brauer and W Anwand doi: 10.1088/1742-6596/225/1/012035 Tag this article Abstract References Full text PDF (686 KB)

012034 Muon spin spectroscopy of the rod-like liquid crystal 4-*n*-octyl-4'-cyanobiphenyl (8CB) I McKenzie, H Dilger, R Scheuermann and A Stoykov doi: 10.1088/1742-6596/225/1/012034 Tag this article Abstract References Full text PDF (1.84 MB)

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012057 Defect studies with positrons: What could we learn on III-nitride heterostructures? Filip Tuomisto, Jussi-Matti Mäki, Olli Svensk, Pekka T Törmä, Muhammad Ali, Sami Suihkonen and Markku Sopanen doi: 10.1088/1742-6596/225/1/012057 Tag this article Abstract References Full text PDF (479 KB)

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Field and temperature dependent charge transport characteristics in regio-regular Poly(3-octylthiophene-2,5-diyl) studied by Muon Spin relaxation

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Field and Temperature Dependent Charge Transport Characteristics in Regio-regular Poly(3-octylthiophene-2,5-diyl) Studied by Muon Spin Relaxation

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Abstract. Spin dynamic of regio-regular Poly(3-octylthiophene-2,5-diyl) has been investigated with longitudinal field (LF) muon-spin-relaxation (μSR) techniques. The LF dependent muon-spin depolarization rate indicates the occurrence of dimensional crossover from one-dimensional intra-chain spin diffusion to three-dimensional inter-chain spin diffusion at 50 K.

1. Introduction

Polythiophene (PT) and its derivative are among the conducting polymers which have been of great research interest due to their chemical and thermal stability [1] as well as their broad applications and possibilities of new applications [2]. They are also easily grafted with side changes for property modifications [3]. In particular, the PT derivative of poly(3-alkylthiophene) (P3AT) has been attracted intensive study because of the effective modification of its properties by variations of the alkyl side-chain length [4]. For instance, conductivity was reported to decrease with increasing alkyl side chain length while stronger luminescence was observed in the case longer chain length [5]. The dependence of hole mobility on the alkyl chain length has also been reported, with the poly(3-hexylthiophene) showing the highest hole mobility among the series of P3AT [6].

We have studied the microscopic and intrinsic charge transport processes in both regio-regular and regio-random poly(3-hexylthiophene-2,5-diyl) (P3HT) by measuring their of longitudinal field (LF) muon-spin-relaxation (μSR) behaviors [7, 8]. The muonium, being made up of a positive muon and an electron, is readily formed as slows down to a near stop in the sample and picks up an electron from a carbon double bond in the polymer, thereby attaching itself to the carbon atom by sharing the electron. This leaves an unpaired electron at the neighbor carbon atom. Following a rapid electronic and structural relaxation of the surrounding polymer,

