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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 (μ SR) 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 (μ SR) 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,