

Dimensional Cross Over in Regiorandom Polythiophene Studied by Muon Spin Relaxation

Risdiana^{1,2}, Fitrilawati², R. Hidayat³, R. E. Siregar², M. O. Tjia³, I. Watanabe¹

¹*Advanced Meson Science Laboratory, Nishina Center, RIKEN, Japan.*

²*Department of Physics, Padjadjaran University, Indonesia.*

³*Department of Physics, Bandung Institute of Technology, Indonesia.*

Email: risdiana@riken.jp

The discovery of conducting polymers opened up many new possibilities for wide ranging and growing applications in many fields such as for devices combining unique optical, electrical, and mechanical properties. One of the materials being intensive studied is the polythiophene (PT) based polymers. Compare with other systems of conducting polymers, the polythiophene form an important class for certain practical advantages such as easily synthesized and doped with various dopant, chemically, thermally and environmentally stable in air and moisture both in doped and undoped states, easily modify by side change substitution for property modifications and have potential applications to be commercialized including field-effect transistors, solar cells, batteries and diodes.

The most notable properties of these materials are their electrical conductivity resulted from the delocalization of electrons in the polymer backbone via doping to the conjugated π -orbital. These properties are related with the charge carrier transport and its mobility along (intra) and perpendicular (inter) to the polymer chain. So far, the macroscopic electronic transport measurement of conducting study of PT has been reported that the functional properties of these polymers depend strongly on their structures [1]. For instance, the conductivity of PT depends on its regioregularity. However, most of the previous studies on those structural effects were conducted by means of transport measurements and photo luminescent spectroscopic measurements, which did not reveal directly the intrinsic and local effects.

We have studied the microscopic intrinsic charge transport in the polythiophene (PT) based polymers with regiorandom structure along the chain and perpendicular to the chain by longitudinal field (LF) muon-spin-relaxation (μ SR) method to elucidate the intra-chain hopping mechanism and inter-chain coupling effects, which can be related to electrical and optical properties. We found the charge carrier mobility changes from intra-chain to inter-chain diffusion at 75 K. The present results indicated that the dimensional cross over from 1 dimensional intra-chain diffusion to 3 dimensional inter-chain diffusion is observed in the samples.

[1] R. Hidayat *et al.*, Jpn. J. Appl. Phys. **40** (2001) 7103.