

CHAPTER I INTRODUCTION

Since the 1970s, the discovery of conductive polymers has been unique in its accomplishment as a possible substitute for metallic conductors and semiconductors due to several advantageous such as lightweight, inexpensive and potentially processible nature. Conductive polymers are a new class of organic materials; these materials generally are comprised simply of C, H and simple heteroatoms such as N and S, and π -conjugation electrons (Chandrasekhar, 1999). The intrinsic electronic conduction in these polymers is achieved by the movement of charge carriers. These carriers can move efficiently along a conjugated polymer chain (interchain transport) (Davidson and Ponsonby, 1999) relative to the non-conjugated polymers.

Among the numerous conducting polymers that have been developed and studied over the past years, poly(3,4-ethylenedioxy thiophene), also known as PEDOT, has developed into one of the most successful materials, from both fundamental and practical perspectives (Groenendaal *et al.*, 2000). The materials resulting from combination with poly(styrene sulfonic acid), PEDOT/PSS (Figure 1), is being applied in several industrial applications ranging from antistatic material in photographic film to electrode material in inorganic electroluminescent lamps.

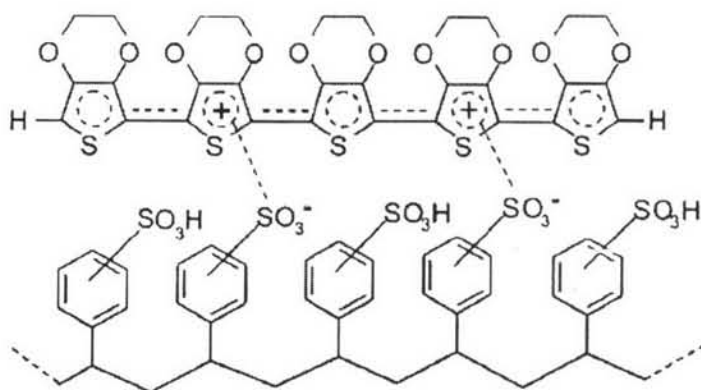


Figure 1.1 Structure of PEDOT/PSS.

PEDOT/PSS has emerged as a promising material for actuator application. It has many advantages over other conducting polymers, such as a high transparency in the visible range, excellent thermal stability, and it can be processed in aqueous solution (Heywang and Jonas, 1992; Groenendaal *et al.*, 2000). However, PEDOT/PSS also suffers from low conductivity: commercially available PEDOT/PSS (Baytron P. Bayer Corporation) has a conductivity of less than 1 Scm^{-1} , which is lower than that of some good conducting polymers by one or two orders of magnitude. Recently, it has been observed that the conductivity of PEDOT/PSS films can be enhanced by more than an order of magnitude by the addition of polyalcohols (alcohols with more than two OH groups on each molecule) or high-dielectric solvents, such as dimethyl sulfoxide (DMSO), to a PEDOT/PSS solution (Pettersson *et al.*, 2002; Ghosh and Ing anas, 2001; Zhang *et al.*, 2002; Kim *et al.*, 2002; Lee *et al.*, 2003). The mechanism for this observed conductivity enhancement has been debated.

The exchange of electrical energy for mechanical energy has been of scientific and technological interests for many decades. Electromechanical energy conversion has been applied in various applications such as muscle/insect-like actuators, robotic, etc (Krause *et al.*, 2001). Electroactive polymers (EAPs) offer promising and novel characters such as light-weight, high energy density and high flexibility; they are suitable material candidates for muscle-like actuators. On the other hand, dielectric elastomers are a type of electric-field-activated electroactive polymer that is capable of undergoing large strains, possessing fast response, and high efficiency (Kornbluh *et al.*, 2002).

Poly(dimethyl siloxane) (PDMS) gel is one type of dielectric materials which has many advantageous characters; a fairly transparent polymer having high elasticity and low stiffness, and high stability. PDMS is an elastomeric polymer because it can recover its shape after being stretched or deformed, and it is also an insulating polymer. A desirable property is that it can allow large actuation strains by subjecting the material to an electrostatic field.

In this study, we describe the synthesis and characterization of PEDOT/PSS, and investigate the electrorheological properties under oscillatory shear deformation in the linear viscoelastic regime. We focus particularly on the effects of particle conductivity and particle concentration of PEDOT/PSS and PEDOT/PSS/EG blend with PDMS gel under various electric field strengths on the storage and loss moduli.