CHAPTER I

INTRODUCTION

1.1 Background

Nowadays, carbon nanoparticles, which are considered as promising materials for using in various applications (in appendix A) such as electrodes of fuel cell, battery storage, filler of polymer, nanocomposite of solar cell, have gained increasing interest. 'Arc discharge in liquid' has been proposed as one of novel technique to synthesize carbon nanoparticles (CNPs). With this method arc plasma is generated between two graphite electrodes (H.W. Zhu *et.al.*, 2002; Lange *et.al.*, 2003). Advantages of this method are its simplicity, low setting cost, and no requirement of vacuum facilities. Other well known methods to fabricate such carbon nanostructures are alcohol-catalytic chemical vapor deposition (alcohol-CCVD) (Nishide *et.al.*, 2004), thermal pyrolysis of ferrocene (Sano *et.al.*, 2003) and laser ablation (Bekyarova *et.al.*, 2002). So far there are many groups investigating the effects of various operating parameters on the characteristics as well as yield of the synthezied carbon nanoparticles. For instance, it has been reported that arc discharge under a nitrogen atmosphere essentially needs investment higher than others arc's method (Cui *et.al.*, 2002), while arc discharge in liquid benzene could provide high yields however the product selectivity is found to be unsatisfactory (Sano *et.al.*, 2003). On the other hand, arc discharge in inorganic molybdenum disulfide catalyst could provide single wall carbon nanotubes, however the poor distribution of those metals distribute results in low production yield (Sano *et.al.*, 2003). Thus a novel synthesis

method with higher effectiveness is required to decrease operating cost and to increase the production yield. More recently, synthesis of various carbon nanostructures by electrical arc discharge in liquid media (deionization and liquid nitrogen) (Antisari *et.al.*, 2003) is further reported that modification of the system components, such as the liquid media, the material of electrodes could provide some novel products with relatively low cost (Sano *et.al.*, 2004). It is strongly believed that such method will be one of the most promising means for the actual industrial applications.

Novel point of this work is that instead of using carbon electrode as cathode, a pure iron bar is employed in arc discharge with expectation of catalytic function on its surface. Some preliminary investigation has been conducted to verify that such proposed system could provide new products which are different from those of the conventional system. Carbon nanoparticles obtained will then be employed as filler for polymer nanocomposite. It is also known that some nanoparticles could be used for supporting MAO and Metalocene in polymerization of linear low-density polyethylene (LLDPE) (Bunjerd *et.al.*, 2005). Therefore this work will set its second objective to employ the synthesized carbon nanoparticles as filler support to produce a novel composite of carbon nanoparticles and polymeric matrix.

1.2 Objectives of study

To study the effects of current discharge on the structure and the yield of carbon nanoparticles and to apply the product as nano-filler for synthesizing polymer nanocomposites.

1.3 Scopes of research

1. Design and construct the arc discharge apparatus
2. Study the effect of the discharge current of liquid nitrogen
   2.1 Arc discharge of 50-125A in C-C electrodes
   2.2 Arc discharge of 100-250A in Fe-C electrodes
3. Characterize obtained carbon nanoparticles by
   - TEM (Transmission Electron Microscopy, JEOL2010)
   - DLS (Dynamic Light Scattering, MALVERN, ZETASIZER 300HSA)
   - Raman Analysis (Perkin Elmer, Spectrum GX NIR FTRaman)
6. To prepare characterize nanocomposite of carbon nanostructures in polymer nanocomposites
   - Study the effect of concentrations carbon nanoparticles on characterization of polymer powder such as melting temperature of the obtained products.
7. Characterize obtained polymer nanocomposites by
   - DSC (Differential Scanning Calorimetry, Perkin Elmer, Diamond DSC Differential Scanning Calorimeter)

1.4 Expected benefits

1. Understanding in the effect of electricial current and liquid nitrogen on the observed nanostructures and yield of nanoparticles.
2. Knowledge of arc discharge method should be adaptable for mass production of nanoparticles in industry and should be applied the product as nano-filler for synthesizing polymer nanocomposites.