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Conversion of Electrospun Polyarylonitrile (PAN) into Carbon Fibres

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ABSTRACT

Electrospun polyacrylonitrile (PAN) polymer is one of the most often utilised precursors for the synthesis of carbon fibres. In this work, PAN was electrospun prior to stabilisation at 280°C and carbonisation at 1200°C. The carbonisation process has successfully converted the electrospun PAN into carbon fibres with approximately similar diameter produced. The ATR-FTIR spectrum shows the as-received and as-spun PAN have a similar chemical structure showing all the solvent has completely vaporised. The conversion of electrospun PAN into carbon fibres are evident from the ATR-FTIR spectrum and XRD peak. There is no apparent peak in the ATR-FTIR spectrum due to the absorbing nature of black carbon, but the XRD data reveals two diffraction peaks at scattering angles of 25° and 44°, which are identical to those previously described for graphitic structures. The conductivity of the carbonised electrospun PAN was found to be 14.2 ± 0.04 Scm^{-1} which is in agreement with findings from others. This indicates that the carbonisation parameter used in this study is sufficient to synthesize a carbon fibre with a moderate conductivity level which is suitable to be used as electrical conductors or in semiconductor applications.

Keywords: Electrospinning, electrospun PAN, carbonisation, carbon fibres

1. INTRODUCTION

Electrospinning is one of the methods to produce fibres in a submicron to nano diameter range effectively. It has been used to produce electrospun PAN which has been popular as a precursor for carbon fibres [1]–[8]. Subsequent carbonisation of the electrospun nanofibrous PAN membranes in an inert environment yields a nanofibrous membrane of pure carbon fibres [9]–[11]. These carbon fibres are of great interest having wide reaching applications including as membrane filters, electronic devices and as composite reinforcement to improve their mechanical properties and impart conductivity where appropriate[12], [13].

Successful conversion of electrospun PAN to carbon fibres varies depending on the stabilisation and carbonisation conditions such as the temperature, the types of inert gas and the heating rate[5]. The low temperature carbonisation stage leads to low degree of carbonisation thus result in lower crystallinity and electrical properties[14]. This is especially true for the electrical properties of the carbon fibres produced where some the conductivity obtained is rather low due to the temperature of the stabilisation and carbonisation stage.

Numerous research has shown the effects of carbonisation process to the chemical structure and the crystal structure of the carbon fibre [5], [12]. However, the whole process of synthesizing the carbon fibres often did not discuss the electrical properties obtained. Thus, in this work, the conversion of the electrospun PAN into carbon fibres is discussed and the electrical property is evaluated.

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