FABRICATION OF NICKEL-COBALT INTERMETALLIC NANOTAPES BY ELECTROSPINNING

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UNIVERSITI MALAYSIA PAHANG

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Applied Science (Honor) Material Technology

FACULTY OF INDUSTRIAL SCIENCES &
TECHNOLOGY
UNIVERSITI MALAYSIA PAHANG

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SUPERVISORS' DECLARATION

I hereby declare that I have checked the thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Honor) Material Technology.

Signature

Name of Supervisor	:	PROF. DR JOSE RAJAN
Position	:	PROFESSOR
Date	:	

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature	:	
Name	:	NOOR ATHIRAH BINTI ISMAIL
ID Number	:	SC 13060
Date	:	

DEDICATION

Dedicated to my family for their love, support and success in my life

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First and foremost, thanks and grateful to the God, for the good health and blessing to complete the project successfully.

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LIST OF SYMBOLS

~	-	approximately
%	-	percent
μ	-	micron (10^{-6})
2θ	-	Bragg angle
^{o}C	-	degree Celsius
g	-	grams
h	-	hour

LIST OF ABBREVIATIONS

EDX	-	Energy dispersive x-ray spectroscopy
FESEM	-	Field emission scanning electron microscope
NiCo	-	Nickel cobalt
TEM	-	Transmission electron microscope
TGA	-	Thermogravimetric analysis
XRD	-	X-ray diffraction

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ABSTRACT

This dissertation thesis is on the fabrication of Nickel-Cobalt nanotapes prepared by electrospinning technique. Electrospinning is a nanofabrication technique in which a polymeric solution is allowed to pass through an electric field of intensity ~10^5 V/m. In this work, the precursor polymeric solution was prepared by dissolving equimolar nickel acetate (18 mmol) and cobalt acetate in 50 wt.% polyvinylpyrrolidone (Mol. Wt. 40,000) in ethanol. The viscosity of the above solution was measured using a viscometer; the viscosity of the solution was ~653 cP. This solution was electrospun using a commercial electrospinning unit at 24 kV with a solution injection rate 0.5 ml/h. The as-spun fibers were annealed in an argon atmosphere at ~450 – 550^{o}C for 1 h, based on thermogravimetric analysis. The annealed materials were examined by X-ray diffraction (XRD) technique and field emission scanning electron microscopy (FESEM). The XRD measurements showed that the annealed samples were only partially crystallized and has a belt-like morphology.

ABSTRAK

Tesis ini adalah mengenai pembuatan nanopita nikel cobalt disediakan menggunakan teknik putaran elektro. Putaran elektro adalah teknik fabrikasi nano di mana larutan polimer dibenarkan untuk melalui medan elektrik intensiti ~10^5 V/m. Dalam kajian ini, cecair polimer telah disediakan dengan melarutkan sama molar nikel asetat (18 mmol) dan kobalt asetat di dalam 50 wt.% Polyvinylpyrrolidone (Mw. 40,000) dalam etanol. Kepekatan cecair polimer di atas diukur menggunakan meter kepekatan; kepekatan cecair polimer adalah ~ 653 cP. Cecair polimer ini telah diputar elektro menggunakan mesin putaran elektro komersial pada 24 kV dengan kadar 0.5 ml/h. Gentian as-diputar telah panaskan dalam gas argon pada ~ 450 - 550oC selama 1 jam, berdasarkan analisis Termogravimetri. Bahan-bahan yang terbentuk setelah dipanaskan telah diperiksa dengan sinar-X pembelauan (XRD) mikroskop teknik dan elektron imbasan (FESEM). Pengukuran XRD menunjukkan bahawa sampel hanya sebahagiannya terhablur dan mempunyai bentuk tali pinggang **.**

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE PROBLEM

Nanotechnology and nanomaterial influence our daily life in many ways – such as in information processing and storage devices, cosmetics, filter membranes, medical instruments, and so on. Interest in nanomaterials and nanotechnology stem from the lecture of the Nobel Laurette, Richard P. Feynman through his famous lecture “There’s plenty of room at the bottom.” opened up the potential of nanotechnology. Research and development have been made to improvise the nanotechnology and innovations to produce various nanostructures for a large number of modern technological devices and applications.

Information storage and processing are one of the areas showed tremendous applications using nanomaterials. A trend in the information processing is in Figure 1.1. This is because, mostly, magnetic nanostructures are used for information storage and properties such as giant magnetic resonance and colossal magnetic resonance have been employed for faster information retrieval. Furthermore, magnetism is a nanoscale phenomenon and the magnetic domains in a magnetic material has nanometer-size dimensions. Therefore, it is a need to fabricate magnetic structures with desirable characteristics to be used for various applications.

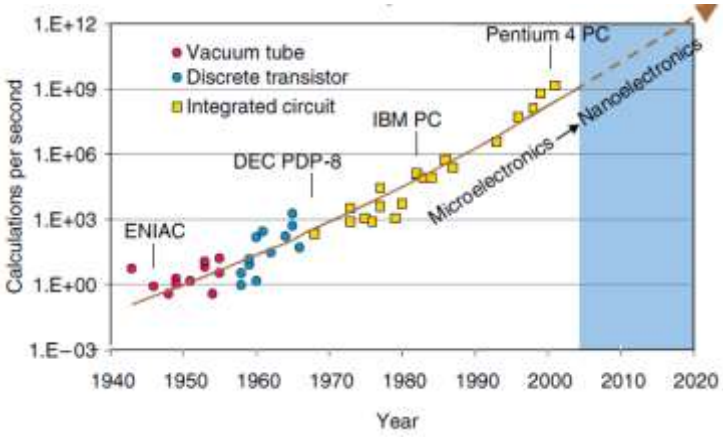

Figure 1.1: The increasing of the component in computing and information technology. Source: Small Wonders, Endless Frontiers: A Review of the National Nanotechnology Initiative (Anon 2002)

Many types of magnetic nanostructures are used in devices – the most common one if the iron-based such as magnetite. Magnetic alloys are an important class of magnetic materials because of its high degree of magnetization, magnetic susceptibility with varying magnetization. Magnetism is an anisotropic property. One-dimensional nanostructures such nanowires, nanorods, and nanofibers are therefore expected to show improved magnetic properties because of its anisotropic nature. Many techniques are developed for fabricating one-dimensional nanostructures; however, electrospinning is currently the only one technique allowing to fabricate long length nanowires in large quantities.

Broadly used technology for formation of electrostatic fiber, electrospinning utilizes the production polymer fiber with 2nm diameter ranging . Different sort of morphologies also can fabricate such as beaded, ribbon, porous, core-shell and alignment with a wide range of nanofibers made of natural polymer, ceramic precursors ,metal, non-metal oxide and an even polysaccharide can be used as electrospun.(Chew et al 2006) (Dong et al 2011). Providing higher surface area than another method, electrospun successfully applied in various field such as biomedical, nanocatalyst, tissue engineering, filtration and so on. Statistic various type of application of nanofibers is in Figure 1.2.

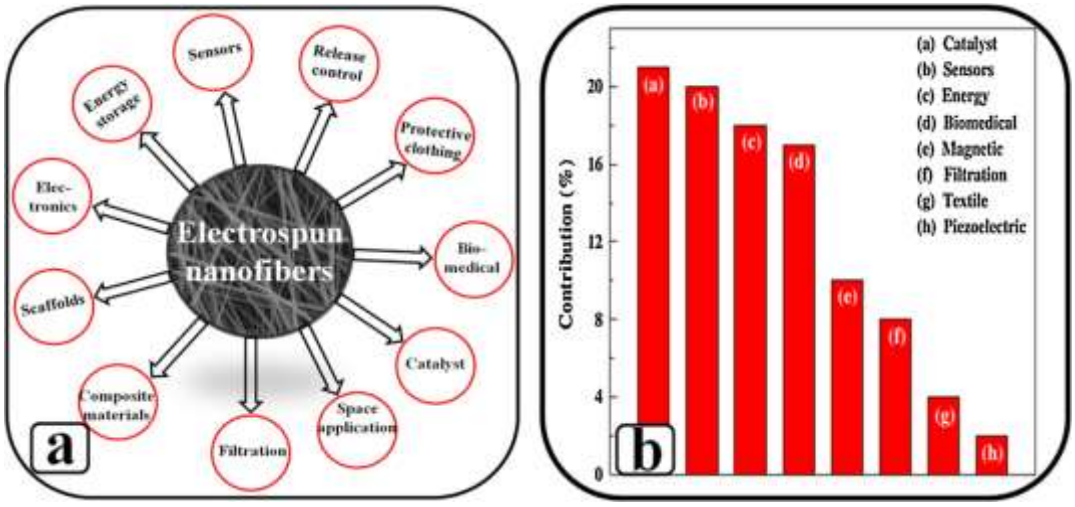

Figure 1.2: Statistic various type of application of nanofibres.

Source : Electrospun polymeric nanofibers encapsulated with nanostructured materials and their applications. (Panthi *et al* 2015)

1.2 STATEMENT OF THE PROBLEM

Recently, the effectiveness of data storage capabilities was increased when the size of magnetic structure decreases (Avcu et al 2014) so the nanostructure material the most important things to synthesize the permanent magnet are through strong shape anisotropy. Aluminum nickel cobalt (AlNiCo) is a permanent magnet which widely used in industry – such as in medical application, generator, sensors, and so on. Composed of an alloy of Aluminium, Nickel and cobalt, AlNiCo manufactured using sintering process. This magnet has strong shape anisotropy but its performance show low coercivity in many range of temperature. Previous published recorded the fabrication of permanent magnet material $Co_{80}Ni_{20}$ nanowire by using the electrochemical decomposition method resulting the formation of strong shape anisotropy, large coercivity, almost temperature-independent could be used as AlNiCo magnet (Maurer et al 2007). However, electrochemical decomposition method limits the fabrication of $Co_{80}Ni_{20}$ nanowire in larger scale.

Furthermore, electrochemical decomposition method arises many problems such as contact problem when dealing with magnetic material, the expensive and limitation the fabrication in large scale. While the electrospinning process allows the fabrication in

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