Processability of Calcined Tin Dioxide Nanoparticles DPNR (Deproteinized Natural Rubber) through Melt Compounding Method using Two Roll Mill

MUHAMMAD HAAFIZ BIN RAHIM
B091910360

BACHELOR OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY WITH HONOURS

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DECLARATION

I declare that this Choose an item. entitled " Processability of Calcined Tin Dioxide Nanoparticles DPNR (Deproteinized Natural Rubber) through Melt Compounding Method using Two Roll Mill '' is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	Haafiz
Name	:	Muhammad Haafiz Bin Rahim.
Date	:	06 JUNE 2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical and Manufacturing Engineering Technology with Honours.

Signature :

Supervisor Name : Sir Hairul Effendy bin Ab. Maulod

Date : 15.01.2023

DEDICATION

This report is dedicated to my beloved family in particular, for their endless love, support and encouragement. To my supervisor Sir Hairul Effendy Bin Ab Maulod who has guided me along the way to finish this project. Thank you for all your support, and give me strength until this project is finished.

ABSTRACT

Nanotechnology has become the most promising research area because of its wide-ranging applications in all scientific fields. Due to its intriguing properties, calcined tin oxide has gotten a lot of attention lately, thanks in part to the nanometer-scale synthesis that has made it even better. Many physical and chemical methods are now being used to make nanoparticles of calcined tin oxide. There are less expensive alternatives, but the synthesis involves a variety of toxic chemicals and is time-consuming and expensive. The development of a cost-effective and environmentally friendly process for its production has been spurred on by concerns about human health and the environment. In this study, deproteinized natural rubber (DPNR) were used to combine with calcined tin oxide nanoparticles (SnO2) as the fillers. This project will undergo melt compounding method and hot pressing process to produce the combination of deproteinized natural rubber (DPNR) and calcined tin dioxide nanoparticles (SnO2). Thus, this review summarises the methods used for the synthesis of tin oxide nanoparticles with deproteinized natural rubber (DPNR) and the impact on their properties. Research on the parameters and characterization methods is also discussed in this paper, along with some of the new findings that have come to light in the process.

ABSTRAK

Nanoteknologi telah menjadi bidang penyelidikan yang paling menguntungkan kerana aplikasinya yang meluas dalam semua bidang saintifik. Disebabkan sifatnya yang menarik, timah dioksida telah mendapat banyak perhatian akhir-akhir ini, sebahagiannya berkat sintesis skala nanometer yang menjadikannya lebih baik. Banyak kaedah fizikal dan kimia kini digunakan untuk membuat zarah nano timah dioksida. Terdapat alternatif yang lebih murah, tetapi sintesisnya melibatkan pelbagai bahan kimia toksik dan memakan masa serta mahal. Pembangunan proses yang kos efektif dan mesra alam untuk pengeluarannya telah didorong oleh kebimbangan mengenai kesihatan manusia dan alam sekitar. Dalam kajian ini, getah asli ternyahprotein (DPNR) digunakan untuk bergabung dengan nanozarah timah dioksida (SnO2) sebagai pengisi. Projek ini akan melalui kaedah sebatian cair dan proses penekan panas untuk menghasilkan gabungan getah asli ternyahprotein (DPNR) dan nanozarah timah dioksida (SnO2). Oleh itu, ulasan ini meringkaskan kaedah yang digunakan untuk sintesis nanozarah timah dioksida dengan getah asli ternyahprotein (DPNR) dan kesan ke atas sifatnya. Penyelidikan tentang parameter dan kaedah pencirian juga dibincangkan dalam kertas ini, serta beberapa penemuan baharu yang telah didedahkan dalam proses tersebut.

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LIST OF SYMBOLS AND ABBREVIATIONS

UTeM	-	Universiti Teknikal Malaysia Melaka
DPNR	-	Deproteinized Natural Rubber
SnO_2	-	Tin Dioxide
kg	-	Kilogram
phr	-	Per Hundred Rubber
ZnO	-	Zinc Oxide
CBS	-	Sulfenamide
TMTD	-	Tetraethyl Thiuram Disulphate
°C	-	Degree Celsius
ASTM	-	American Society for Testing and Materials
°	-	Degree

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CHAPTER 1

INTRODUCTION

1.1 Background

SnO2 is the chemistry formula for Tin dioxide. The chemical compound stannic oxide is another name for tin dioxide. One tin atom and two oxygen atoms make up tin dioxide, an inorganic molecule. Tin (IV) oxide, often known as stannic oxide, is another name for SnO2. Tin oxide has the formula SnO2 as its chemical formula. The oxidation state of the tin in this compound is +4. As a result, tin (IV) oxide is the designation given to it. Tin (IV) oxide is another mineral that can be found in the Earth's crust. In its mineral form, cassiterite is an oxide of tin (IV). One of the most important tin ores on the planet is found in this location. Tin (IV) oxide compounds, whether ionic or covalent, are known by the chemical name SnO2. Basically, tin dioxide is refined by metal reduction and burning in the presence of air[1]

A solid with a melting point of 2966 degrees Fahrenheit, tin (IV) oxide is colourless and appears to be inorganic. It weighs 6.95 g/cm^3. It is not water-soluble. The rutile structure is crystallised by using Tin(IV) oxide. Tin atoms and oxygen atoms have six and three coordinates, respectively. SnO2 is typically thought of as an n-type semiconductor since it lacks oxygen in its structure. Tin dioxide is more thermally stable than SnO in terms of its chemical characteristics. It is an amphoteric acid that reacts with both acids and bases.

There is some uses of tin dioxide which is ceramic glasses are made using tin oxides.There are a number of dyes that employ tin oxide as a pigment. Next,surfaces are polished with tin oxides. By using tin dioxide, detecting gas is also possible with its help. As a catalyst, tin oxides are utilised in numerous chemical reactions, such as photosynthesis. As a lighting agent, it's a popular choice[2]

Deproteinized Natural Rubber (DPNR) is a natural rubber that has had the protein and ash removed. This rubber is produced in a controlled environment. It has a higher percentage of rubber hydrocarbons than regular natural rubber grades, which have a lower percentage [3] . Removal of non-rubber components enhances the value of the rubber in particular applications by providing unique properties. The characteristics of DPNR is it has a low protein level, which makes it unique. It has a very low levels of dirt and ash where the volatile matter content is low. It is also light-colored and no detectable amount of nitrosamines[4].

DPNR is offered in two main grades. First DPNR CV, it is between 60 and 70 Mooney units of viscosity have been stabilised. Secondly, DPNR S, the disadvantages is there is no viscosity stabilisation between 70 and 80 Mooney units, the initial viscosity is found. The DPNR S has a substantially lower storage hardening than the regular natural rubber because of the education on non-rubber content [5]

1.2 Problem Statement

Before this, calcined tin dioxide (SnO2) is produced basically by evaporation process where the Silicon (Si) are used as the substrate. The problem that occur at the end of this process is, it is difficult to produce tin dioxide due to its high melting point which is by 2966 degree Fahrenheit. A changes happened on the mechanical properties at the base material (tin dioxide) after the process.[6] As a result, this study basically is now trying to develop new opportunity to change the available properties of Deproteinized Natural Rubber (DPNR) to a better version. In other hand, by studying this project it is able to expand the area of application that is suitable based on the new parameters or properties.

A product can no longer be made solely from Natural Rubber due to the skyrocketing cost of the raw material. To meet the needs of the consumer, the study needs a few components that can be mixed with Natural Rubber to produce better quality products. Fillers can be added to Deproteinized Natural Rubber (DPNR) to enhance its properties, according to the findings, mechanical and physical properties can be improved by using fillers like Calcined Tin Dioxide Nanoparticles that is mainly used in this study to produce a better properties.

1.3 Research Objective

The objectives are as follows:

a) To produce Deproteinized Natural Rubber (DPNR) with different percentage content of Calcined Tin Dioxide Nanoparticles (SnO2) using melt compounding method.

b) To investigate the impact for different volume of Calcined Tin Dioxide Nanoparticles (SnO2) in the formation of Deproteinized Natural Rubber (DPNR) in terms of time, temperature and torque.

1.4 Scope of Research

Through the melt compounding method, this study will investigate the "Processability of Deproteinized Natural Rubber Reinforced (DPNR) with Calcined Tin Dioxide Nanoparticle." It also examines the physical properties of Deproteinized Natural Rubber (DPNR) compounded with Calcined Tin Dioxide Nanoparticle (SnO_2) through the use of a hot press machine and mechanical tests, such as tensile testing. This study also will analyse the specimen using under optical microscope. The study of this subject may have a positive impact on the surrounding area while improvise the properties.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An important n-type semiconductor oxide, tin oxide (SnO2) has a band gap of approximately 3.6–4.0 eV. These properties include high electrical conductance, high transparency to visible light, and strong interactions between certain toxic gas molecules and its surfaces . Transparent electrodes, liquid crystal displays, solar cells, and lithium-ion batteries are just a few of the many potential uses for SnO2 due to its unique properties. For semiconductor gas sensors, SnO2 is an important material. Nanostructures of SnO2 in various forms such as nanofibers, nanowires, and nanoparticles have been widely studied in recent years in an effort to expand their applications in the scientific community[6]

2.2 Deproteinized Natural Rubber (DPNR)

Latex from Hevea brasiliensis, the plant that produces natural rubber (NR), contains 30–40% rubber by weight dispersed as rubber latex particles in water, along with a few minor nonrubber components. There is cis-1,4-polyisoprene encased by proteins and lipids on the outside of freshly formed rubber particle latex particles. Natural rubber latex particles are thought to have a protein layer that is only found on the particle's surface. Type I immunoglobulin E, which is found in high concentrations on the surface of NR particles in the latex state, has been implicated in the development of latex allergy. Deproteinized NR latex, particularly for medical devices and hypoallergenic products, has seen an increase in demand due to the potential protein allergy risk in NR products for sensitised users[7].

A number of different chemical and enzyme methods for deproteinizing NR have been described. By enzymatic degradation, proteins on the rubber particle's surface were effectively removed in the latex stage. As a result, the nitrogen content of NR was significantly reduced to less than 0.02%, or about 5% of the starting material. Aside from the lengthy incubation time required for the enzyme process, the remaining proteins, peptides or amino acids may cause intraoperative anaphylactic reactions in hypersensitive patients of allergy. Within one hour of treatment with urea and saponification, the total nitrogen content was reduced to less than 0.02 wt percent[8]

2.2.1 Production Process of Deproteinized Natural Rubber (DPNR)

Polypeptide-N-Resin (DPNR) is made by hydrolyzing the latex protein in field latex, which is then washed away during processing. In a stainless steel conical bottom reaction tank, ammonia, a non-ionic surfactant, proteinase, and hydroxylamine Neutral Sulphate (HNS) are added to bulked field latex and allowed to react for 72 hours. A steam column coagulator designed specifically for this purpose is used to coagulate the reacted latex after it has been neutralised with diluted formic acid and the enzymatic hydrolysis reaction is complete. [9] The coagula that is formed are then continuously processed through a series of crepers before being shredded into small crumbs in a shredder to finish. Before entering the dryers, the crumbs are pumped through a static screen to remove any foreign matter. A hot air dryer is used to dry the wet crumbs for about six to eight hours at about 85oC. It is after cooling that the SMR standards are met for the packaging of the baked goods[10]

2.2.2 Properties of Deproteinized Natural Rubber (DPNR)

Deproteinized Natural Rubber (DPNR) is characterized as a material that is extremely low concentration of protein. It is because during the process from natural rubber, it already remove the protein that have in the natural rubber. There is also very little grit and ash content. Deproteinized natural rubber (DPNR) also have a low level of volatile matter with a palish colour. There is also no detectable amount of nitrosamines. The antigen content is also extremely low[11]

2.2.3 Grades of Deproteinized Natural Rubber

There are two levels of DPNR training available. In the first DPNR CV, the viscosity has been stabilised between 60 and 70 Mooney units. DPNR S, on the other hand, suffers from a lack of viscosity stabilisation between 70 and 80 Mooney units. The DPNR S has a significantly lower hardening rate than regular natural rubber because of the increased awareness of non-rubber content [11]

2.3 Tin Dioxide Nanoparticles

The wide range of applications of tin oxide semiconductors, such as gas sensors, transistors, electrodes, liquid crystal displays, catalysts, photovoltaic devices, photo sensors, antistatic coating has led to an increase in recent research. It is one of the most important materials because it has a high degree of transparency in the visible spectrum, strong physical and chemical interactions with adsorbent species, a low operating temperature, and strong thermal stability in air up to 5000 °C. Two types of tin oxides are possible because the metal exists in two oxidation states +2 and +4, leading to the formation of both stannous oxide (SnO) and stannic oxide (Sn02). Sn02 is the more stable of the two oxides [12]

Sol Gel, Microwave technique, Solvo-thermal, Hydro thermal, Sonochemical, Mechanochemical, Co-precipitation and other methods have been used to synthesise Sn02 nanoparticles, which have been used in various applications. Co-precipitation has been used to produce Sn02 nanoparticles that are extremely pure and crystallised. It's easy, cheap, and doesn't call for high temperatures or pressures to use this Co-precipitation method Controlling particle size and shape can be done by changing the pH of the medium, increasing the amount of a specific precursor, or precipitating reagents. Filtration and repeated washing of the precipitate removes any remaining impurities [6]

2.3.1 Properties of Tin Oxide Nanoparticles

XRD, or X-ray diffraction, can be used to determine the structural properties of any material. XRD is used to determine the structure of Tin oxide nanoparticles in the angle 2? range of 20° to 70°. These Sn02 nanoparticles have a crystalline structure and are only 36 nm in diameter.

Properties: Tin Nanoparticles

Molar Mass: 150.71 g/mol

Melting point: 1630 °C

Boiling point: 1900 °C

Density: 6.95 g/cm^3

Analyzing the morphology of Sn02 Nanoparticles is done using an SEM. SEM is a scanning electron microscope. SEM reveals a spherical morphology with a foam-like structure. Laser absorption measurements were performed on nanoparticles of SnO2. Between 300 and 800 nm, the optical absorptivity coefficient has been calculated. In this case, the absorption edge is found at a lower frequency. The quantum confinement of the nanoparticles may be responsible for the widening of the absorption spectrum. In optical devices, Sn02 nano parts are promising because of their excellent crystallinity and strong blue emission. Sn02 nanoparticles have an absorbance peak at 315 nm, according to their UV absorption spectrum.

The dielectric studies demonstrate the influence of temperature and frequency on the conductivity phenomenon in nanostructured materials. It is possible to gain useful insight into the electrical properties of the grain boundaries by making use of the dielectric behaviour. The electronic, ionic, dipolar, and space charge polarizations are the primary contributors to the dielectric properties of materials. Space charge polarization also plays a role. The electronic polarization, which can be found in the optical frequency range, is the most essential controlling factor when it comes to the bulk form of polycrystalline materials[2].

Polarization of space charge arises from molecules possessing a persistent dipole moment that, when subjected to an electric field, is capable of undergoing a shift in its orientation. The fundamental electrical properties of Sn02 nanoparticles are referred to as the dielectric parameters. These dielectric parameters include the dielectric constant and the dielectric loss. The electric processes that take place in Sn02 Nanoparticles can be revealed by the measurement of the dielectric constant and loss as a function of varying frequencies and temperatures [1]