



Engineering Physics International Conference, EPIC 2016

## Natural Rubber Nanocomposite as Human-Tissue-Mimicking Materials for Replacement Cadaver in Medical Surgical Practice

Riri Murniati<sup>a</sup>, Sutisna<sup>a</sup>, Edy Wibowo<sup>a</sup>, Mamat Rokhmat<sup>a</sup>, Ferry Iskandar<sup>a</sup> and Mikrajuddin Abdullah<sup>a,\*</sup>

<sup>a</sup>Material Electronics Research Group, Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung Jalan Ganesa 10 Bandung 40132 Indonesia

### Abstract

The utilization of human cadaver in means of medical study has been common. Nonetheless, human cadaver brought inevitable problems. Thus a substitute material is necessary to diminish the usage of a human cadaver. Substitute material needs to heed the potency of Indonesian resources to help the country's development. As the world knows, Indonesia is the world's second largest natural rubber producer. Hence natural rubber composite was chosen as the base material, blends with some silicone rubber. The purpose of this research is to synthesize nanocomposite that has a mechanical characteristic of the human tissue. The precursors will be made with some variations include the optimization type of filler (nanosilica, caolin and CaCO<sub>3</sub>), and the optimization of filler nanosilica volume fraction. The composition of the materials used is also important to observe. Scattering properties are set by adding titanium dioxide, an inexpensive and widely available scattering agent which yields a wavelength dependent scattering coefficient similar to that observed in tissue in the near infrared. Repeatability for the phantom fabrication process will be presented. This research has produced some materials that have a similar mechanical characteristic with internal human tissue characteristic.

© 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the organizing committee of the Engineering Physics International Conference 2016

**Keywords:** Tissue-mimicking materials, nanosilica, caolin, CaCO<sub>3</sub>, natural rubber, cadaver

### 1. Introduction

In medical, cadaver (the human body that has been frozen) is often used as an object of study and research, especially for medical surgical training. However arise some problems behind the use of this cadaver such as durability, costly, availability, and issues of morality. The cadavers that will be studied by medical students come from a range of ages and conditions were completely random [1]. As medical science has progressed, it has become increasingly important to a non-human interactive formats for patient care protocols. While it is desirable to train medical personnel in patient care protocols before allowing contact with real patients. On the other hand, allowing inexperienced students to perform medical procedures on actual patients that would allow for the hands-on practice cannot be considered a viable alternative because of the inherent risk to the patient. Non-human interactive devices and systems can be used to teach the skills needed to successfully identify and treat various patient conditions without putting actual patients at risk [2].

Such training devices and systems can be used by medical personnel and medical students to teach and assess competencies such as patient care, medical knowledge, practice-based learning and systems based practice. The training devices and systems can also be used by patients to learn the proper way to perform self-examinations. In particular, structures for simulating body tissue for use in practicing surgical and/or clinical techniques. In the medical field, it is necessary for students, doctors, and surgeons to be able to practice surgical and clinical techniques. Particularly, there is the need to practice the making of incisions, the removal of various kinds of complaint (such as cysts, and melanomas), access to venous structures below the epidermis and

\* Corresponding author. Tel.: (022) 2500834 fax: (022) 2506452  
E-mail address: [din@fi.itb.ac.id](mailto:din@fi.itb.ac.id)

the insertion of sutures. As an alternative to providing an actual body or part of an actual body for practicing such techniques, there is a need for artificial means whereby they can be practiced. Known structures providing simulations of body tissue suffer from the disadvantage that they are not sufficiently analogous, either visually or physically, to actual body tissue [3].

We use a substitute material to create a mimicking human cadaver through this study. Silicone-based tissue-mimicking phantom is widely used as a surrogate of tissue for clinical simulators, allowing clinicians to practice medical procedures and researchers to study the performance of medical devices [4]. Polydimethylsiloxane (PDMS) tissue simulating phantoms with tunable optical properties to be used for optical system calibration and performance testing in visible and near infrared domain also had been studied. Compared to liquid phantoms, cured PDMS phantoms are easier to transport and use, and have a longer usable life than gelatin based phantoms [5].

Matrix materials typically are water, gelatin, agar, polyester or epoxy and polyurethane resin, room-temperature vulcanizing (RTV) silicone, or polyvinyl alcohol gels. The water and hydrogel materials provide a soft medium that is biologically and biochemically compatible with the addition of organic molecules and are optimal for scientific laboratory studies. Polyester, polyurethane, and silicone phantoms are essentially permanent matrix compositions that are suitable for routine calibration and testing of established systems. The most common three choices for scatters have been: lipid-based emulsions, titanium or aluminum oxide powders, and polymer microspheres [6].

## 2. The object of the study

The novelty of this study uses natural rubber-based tissue mimicking human tissue. This is due to the urgency of material selection in accordance with the potential of Indonesia. So in the manufacture of replacement cadaveric material need to choose a material that has become a mainstay product Indonesia for a long time. The product is natural rubber. This study investigates using some formula of materials to create the desired mechanical properties and surgery characteristics of a tissue-mimicking tissue. The substitute materials have been determined as well as the composite material to be mixed into the rubber material. To be able to have the cadaver characteristics, we choose three types of filler material; caolin, calcium carbonate, and nanosilica. This is to see which is most effective filler in modifying natural rubber character resembles a human cadaver. Then the use of filler will be further optimized by using a variation of the volume fraction. It also conducted a matrix constituent mix between natural rubber and silicone rubber. Then it will do a comparison between the two materials. Silicone itself has a price that is much more expensive than natural rubber. So the comparison also serves to optimization apart from evoking the characteristics of a human cadaver in natural rubber by using a mixture of silicone rubber.

Basically, this experiment is divided into several phases: Phase design and manufacture of hot press mold and incision test equipment, the synthesis of samples, material characterization and retrieval of data, and analysis phase. Molds needed with special specifications, good material, size, and performance. A molding used is made of stainless steel, with a length of 10 cm, width 7 cm, and height 3 cm. Matter other than as container scored also serves as a heater that will enhance curing maturation.

## 3. Methods

The precursors will be made by the optimization of the type of base material used rubber (liquid latex and silicone rubber). Samples were synthesized by mixing several chemicals (Table 1), the formula that is used depends on the type of materials used, the order of input materials, stirring time and the amount of material used. All formulas were found to be tested and repeated continuously until it was the most appropriate formula to produce nanocomposite most similar in structure mechanics with human flesh.

**Table 1.** Formula of the Materials

Materials	phr (part per hundred rubber)
Latex	100
Filler	1,5
TiO <sub>2</sub>	1
Minarex oil	7,5
ZnO	0,5
Stearat acid	0,5
Parafin wax	0,5
Food coloring	1
Texapan	1
CMC	0,5
Sulphur	0,5
Gelling agent	0,5

Do mixing precursor liquid latex with a foaming agent and a curing agent for a certain time (according to the formula), then added with a stabilizer and gelling agent. Meanwhile, another sample was mixed using filler then mixed with a stabilizer and gelling agent. Then the precursors and the material is dried and burned [7]. For a variety of rubber, natural rubber is mixed in

Download English Version:

<https://daneshyari.com/en/article/5029024>

Download Persian Version:

<https://daneshyari.com/article/5029024>

[Daneshyari.com](https://daneshyari.com)