Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

Special Issue

SILICONE RUBBER INSULATOR USING ORGANIC FILLER FROM GOLDEN APPLE SNAIL SHELLS

S. Tepsila[1,*] and A. Suksri[2]

[1]Insulation Technology and High Voltage Engineering Laboratory, Department of Electrical Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen, 40002, Thailand

[2]Center for Alternative Energy Research and Development, Khon Kaen University, Khon Kaen, 40002, Thailand

Published online: 18 April 2018

ABSTRACT

Silicone insulator has been widely used for protecting high voltage outdoor equipments from environmental disturbances. This research aims to improve the properties of silicone rubber room temperature vulcanization (RTV) by using organic filler obtained from golden apple snail shells. The calcium carbonate ($CaCo_3$) with particle size of 75 µm was obtained from golden apple shells. The specimen made of RTV with additional of inorganic filler from commercial grade $CaCO_3$ were compared with organic filler. Samples were tested according to ASTM standard. Experimental results showed that, silicone RTV have shown a preliminary good insulation threshold of properties. For the electrical property, silicone RTV using organic filler ratio of over 30% perform better insulation property than inorganic filler when using the same ratio. As for mechanical property, it was found that the hardness is increased when the filler is increased respectively. $CaCO_3$ from golden apple snail shell created the crease pattern of film cover the surface of silicone RTV when more percentage of the filler used after examined by SEM. Finally, organic filler from golden apple snail shell were found to improve the hydrophobic property of RTV when investigated using contact angle measurement.

Keyword: Insulator Properties, Organic filler, Golden apple snail shell

Author Correspondence, e-mail: sujirat.miin@gmail.com

doi: http://dx.doi.org/10.4314/jfas.v10i3s.67

I. INTRODUCTION

Many materials of insulator are widely used for protect equipment and high voltage outdoor insulation system. The insulator must have a good electrical, mechanical and chemical properties also it does withstand in every environmental [1]. More recently, Polymeric insulator has increasing tendency for replaced other materials because of its excellent performance in many aspects. This exceptional performance of polymer based insulators is directly attributed to the ability of the polymeric material to maintain hydrophobicity on the surface of the material in the presence of severe contamination and wet conditions [2]. Silicone rubber room temperature vulcanization (RTV) is one type of polymeric insulator that plays important role because of its best performance in the specification needs [3]. Many researchers have found that by using additional of filler such as Alminium-Trihydeate (ATH), silica, carbon-black, calcium carbonate ($CaCO_3$) can improve RTV properties. However, these industrial fillers were costly [4]. Therefore, the main object of this research is to improve RTV properties by using organic filler as a replacement for inorganic filler. Organic filler obtained from Golden apple snail shells due to it's mainly composed of calcium carbonate of over 95% [5]. The organic filler is in white powder and it has particle size of less than 75 μm.

II. EXPERIMENTAL SETUP

A. Material and Filler

The Silicone rubber room temperature vulcanization (RTV) is in liquid form as a base material. In order to manufacture it, we have to produce a sample in solid form, the catalysed used with the ratio of 100:3 by weight. Then, wait for the curing of liquid coagulation at the room temperature around 2 to 3 hours. Filler in this study used are divided into 2 type; inorganic filler and organic filler. The inorganic filler is commercial grade calcium carbonate ($CaCO_3$) and organic filler obtained from natural shells. Golden apple shells are mainly composed of $CaCO_3$, sodium oxide and silicon dioxide of 99.302, 0.307 and 0.126% respectively and the rest of the compound oxide types are approximately 0.265% [5]. The preparation the $CaCO_3$ from golden apple snail shells was needed to wash them in clean water to remove dirt. Heat them up to remove moisture contents at 100 °C in the oven for 24 hours, then crushed them after that using the sieve no. 200 to filter the powder for 75μm particle size of $CaCO_3$.

B. Characteristics Investigation

1) Current and Voltage (I-V Characteristic) test

Current- voltage characteristic test is measurement of AC insulation resistance according to ASTM D257-07 [6] standard. This test using AC voltage from transformer and adjust the voltage from 0 to 10,000 V with increment of 100 V for measuring the current through the specimen. The specimen has cylindrical shape. Its radius is 50 mm and 2 mm of thickness.

2) Tensile test

The specimens have a dumbbell shape. The thickness is 4 mm; the width is 6 mm and 33 mm in length according to ASTM D638-02a Type VI standard [7]. The tensile test machine set the crosshead speed at 50 mm/min. Before test begins, measurement of the original dimension and the original gauge lengths has to be read out first. After start the machine, the process involves pulling the specimen until a shear has occurred. Record the elongation, tensile strength, hardness and deflection of maximum load [8].

3) Contact Angle

Measurement of the angle of contact when a drop of liquid is applied a coated surface according to ASTM D7334 standard [9] as shown in fig.1. We measure contact angle at the room temperature using water. Area surface specimen test shall not visible and not be touched with the fingers or contaminate in any other way. The machine set a horizontal stage and deposits a drop size of test liquid no larger than 5 μL. The contact angle measured on this drop will be an advancing contact angle [10] and Water can be used as test liquid to establish as detail in table I.

TABLE I. Classified of the contact angle

Condition	Nature	Effect
$\theta < 90^\circ$	Hydrophilic	Water droplets spread out
$\theta > 90^\circ$	Hydrophobic	Water droplets beads-up
$\theta > 150^\circ$	Super- hydrophobic	Water droplets highly beaded

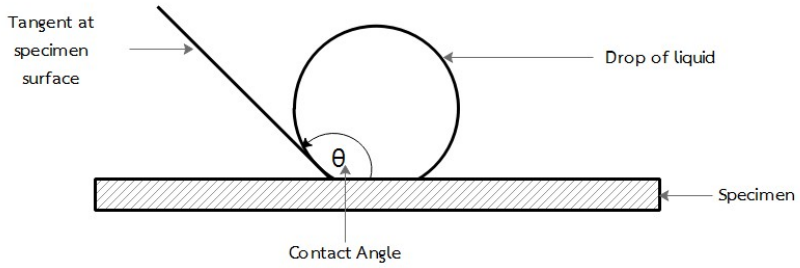


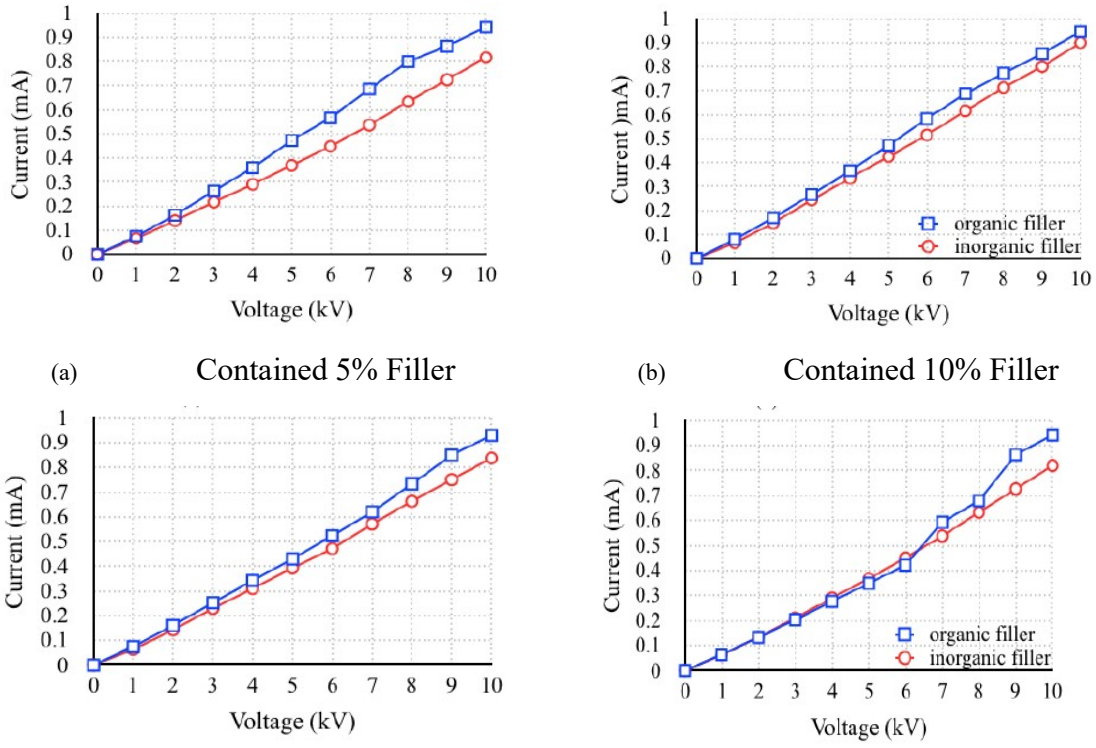
Fig.1. Measuring angle of contact

III. RESALT AND DISCUSSION

C. Current and Voltage (I-V Characteristic)

Fig.2 shows the comparison between the I-V characteristic of RTV using organic filler and inorganic filler with the same ratio of 0 to 50% by weight when voltage is increased from 0 to 10,000 V. RTV using organic filler can oppose the flow of current better than using organic filler from 0 to 30% by weight. However, when the filler was used over 30% by weight, RTV using organic filler has performed well better than inorganic filler.

The 50% of organic filler filled in RTV obtained its best resistivity material as it can oppose the flow of electrical current. On the other hand, the poor resistivity material in term of opposes the flow of electrical current is 5% by weight filler ratio. The inorganic filler used in RTV material have shown similar behavior in term of opposing the flow of electrical current.



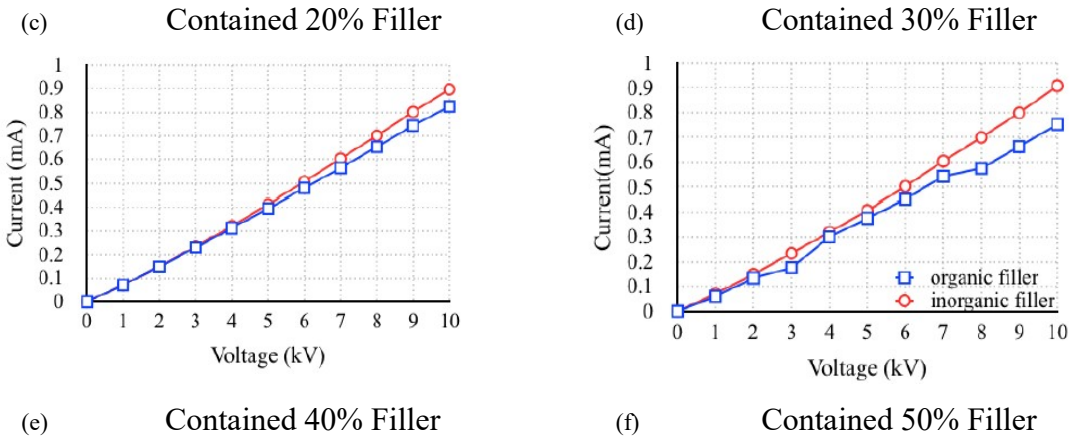


Fig.2. Comparison between the I-V characteristic of RTV using organic filler and inorganic filler in the same ratio

D. Tensile Stress

Tensile strength and elongation of RTV using 5% organic filler revealed a higher value of tensile than using the inorganic filler and the controlled (without filler). When the filler is increased, the elongation of RTV are declining steadily as same as tensile strength as in fig. 3.

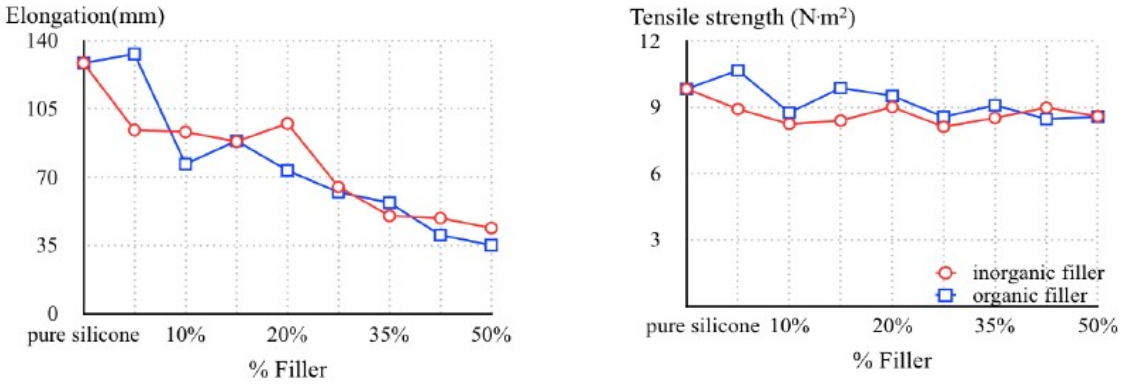


Fig.3. Comparison of (a) elongation (b) Tensile strength of RTV with organic and inorganic filler

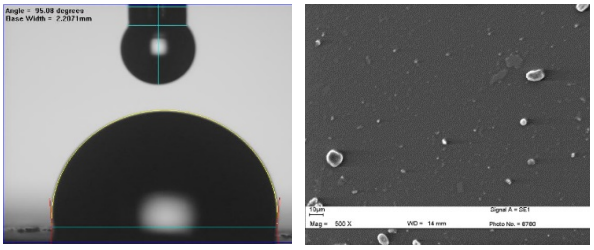
E. Contact Angle & Scanning Electron Microscope (SEM)

We have found that the RTV with Organic and inorganic filler have greater and larger contact angle than the controlled (without filler). Contact angle is increasing when the filler is increased. However, the RTV using organic filler have larger value of contact angle way much better than using inorganic filler as show in fig. 4.

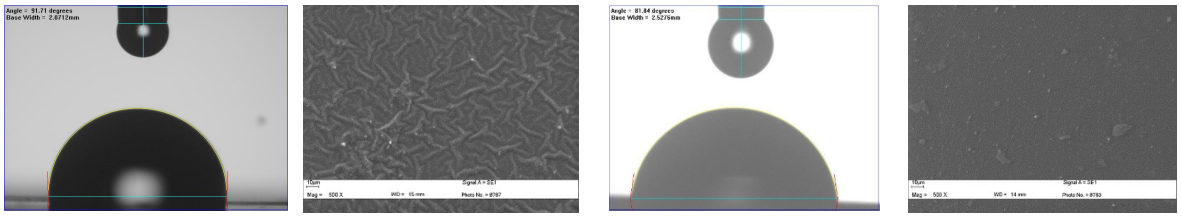
Also, the inspection of the surface by scanning electronic microscopy (SEM) showed the details of silicone rubber using organic filler, inorganic filler and controlled. The surface of RTV without filler has smooth surface and does not have crease pattern of thin film as were

found in inorganic filler with the same filler ratio. But, the surface of RTV using organic filler, were found to have crease pattern thin film cover on surface's specimen and it is increasing when increase the filler as show in fig. 5.

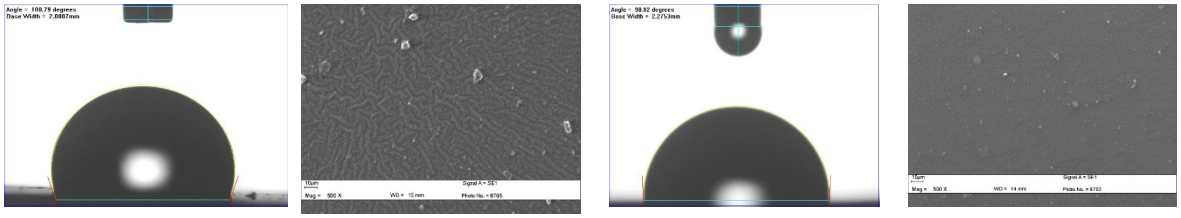
Fig.4. Contact angle of RTV with organic and inorganic filler



(a) Pure silicone



(b) Contained 5% Organic filler (c) Contained 5% Inorganic filler



(d) Contained 50% Organic filler (e) Contained 50% Inorganic filler

Fig.5. Image sequences of water droplets (5µL) of RTV's surface using organic and inorganic filler (Left) and Image of RTV's surface using scanning electron microscope (SEMs) (Right)

IV. CONCLUSION

Silicone rubber room temperature vulcanization using organic filler from golden apple snail shells is probably a potential candidate material in order to be used as an outdoor insulator. It

shows the ability to resist the current flow through itself. Therefore, the equipment or insulation system that is used the filler of over 30% by weight when compare with inorganic filler with the same ratio will help improve its insulation property. As for the tensile strength, with organic filler filled in of 5%, the RTV revealed higher tensile value among those using inorganic filler and without filler. Organic filler obtained from golden apple snail shells helps improve the surface hydrophobic property of RTV when compare to the inorganic filler and controlled (without filler). Preliminary study can be concluded that, the amount of filler used have greater contribution to the electrical, mechanical and chemical properties. However, when the filler were used in an excessive amount, the elongation property of RTV may be achieved and the materials will become more brittle. Finally, organic filler from golden apple snail shell were found to improve the hydrophobic property of RTV when investigated using contact angle measurement.

ACKNOWLEDGMENT

Authors would like to thank you to the Insulation Technology and High Voltage Engineering Laboratory, Department of Electrical Engineering, Khon Kaen University for supported this research. Also, Laboratory in Department of Agriculture Engineering, Khon Kaen University and Integrated Nanotechnology Research Center Khon Kaen University for testing all of the specimens in this research

REFERENCES

[1] Mohammad A, Mohammad A and Salman A, “Hydrophobicity of Silicone Rubber used for Outdoor Insulation (an Overview),” *Rev. Adv. Mater. Sci.*, vol. 16, pp 10-26, Apr.2007.

[2] Jin k k, In-hwan k, “Characteristics of Surface Wettability and Hydrophobicity and Recovery Ability of EPDM Rubber and Silicone Rubber for Polymer Insulators,” *Journal of Applied Polymer Science*. vol. 79, pp 2251-2257, May 2000.

[3] Rodolfo C, Ana C B, Adriano D, Eduardo C M. C, Joceli M G. A, Lucia H I M, “Silicone insulators of power transmission lines with a variable inorganic load concentration: Electrical and physiochemical analyses,” *Measurement*, vol. 50, pp 63–73, Jan 2014.

[4] Sujirat T, Amnart S, “A Study on Modification Properties of Silicone Rubber Using Organic Filler from Golden Apple Snail Shell,”*Key Engineering Materials*, vol. 718, pp 40-44, Nov 2016.

[5] Nittima R, "Nano Calcium Carbonate from Golden Apple Snail and Oyster Shells as reinforcing Filler for Poly (Vinyl Chloride)," *Master Thesis*, Chulalongkorn University, Thailand.

[6] ASTM international, ASTM D257-07 2012, Standard Test Methods for DC Resistance or Conductance of Insulating Materials1.

[7] ASTM international, ASTM D638-02a 2003, Standard Test Method for Tensile Properties of Plastics This test method is under the jurisdiction of ASTM Committee D20 on Plastics and the direct responsibility of Subcommittee D20, p 46-58.

[8] R. Raja Prabu, S. Usa, K. Udayakumar, M. Abdullah Khan and S.S.M. Abdul Majeed, "Electrical Insulation Characteristics of Silicone and EPDM Polymeric Blends – Part I," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 14, pp 1207-1214, Oct 2007.

[9] ASTM international, ASTM D7334-08 2013, Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement.

[10] Davi M. Soares, Serge Mendonça, Est_acio T.W. Neto, Manuel L.B. Martinez, "Electrical field on non-ceramic insulators and its relation to contact angles for constant volume droplets," *Journal of Electrostatics,* vol. 84, pp 97-105, Oct 2016.

How to cite this article:
Tepsila S, Suksri A. Silicone rubber insulator using organic filler from golden apple snail shells. J. Fundam. Appl. Sci., 2018, *10(3S), 785-792.*