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Electrical Textile: Graphite Paste on Gloves for Touching Screen of Smartphones and Tablets

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ABSTRACTS

Wearing personal protective equipment is a must during the covid-19 pandemic when you have to go outside the house. The covid-19 pandemic makes shopping, work, studying, and other activities run at home. With advances in technology, touch screen gloves for smartphones and tablets are a solution so that online service sellers and people who have to leave the house are protected and easily use their smartphones. The purpose of this paper is to prove that the use of graphite media can be used for touch screens on gloves in the use of smartphones and tablets. The population of this research is chemical substances which are conductor, thickener, and binder. The sample used by researchers was graphite as a conductor, alginate as a thickener, and polyacrylate as a binder. The method used is an experimental method and literature review, an experimental method using certain tools and materials in this experiment. The experimental results show that graphite paste can make gloves as a conductor and gloves with polyacrylate has a washing resistance of 10-50 times household washing. The graphite paste is a conductor for making gloves that can touch smartphones and tablets screens also polyacrylate as a binder can make washing resistance. So it can be concluded that graphite can be used for touch screens on gloves in the use of smartphones and tablets and has a washing resistance.

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1. INTRODUCTION

In accordance with the Regulation of the Minister of Health of the Republic of Indonesia Number 9 of 2020 on Large-Scale Social Restrictions freight forwarding services, including application-based two-wheeled transportation facilities with restrictions only for transporting goods and not for passengers. During the COVID-19 pandemic, all business sectors will be stopped except for eight sectors, namely the health, food, and beverage sectors, energy, communication, finance and banking, logistics and distribution of goods, daily needs, and strategic industries. With the advancement of technology, meeting daily needs, working, and learning can be done in one digital tool, namely in a smartphone or tablet. Wearing personal protective equipment is a must during the covid-19 pandemic, including wearing masks and gloves when you have to go out of the house. To give personal protective equipment to medical personnel it is advisable to wear masks and gloves non-medical or among them made from fabric.

With the advancement of technology, touch screen gloves for smartphones and tablets with graphite paste as a conductor are a solution so that online service sellers and people who are forced to leave the house are protected and easily use their smartphones. Based on the problems that occur, the formulation of the problem of this article is how the effect of graphite paste and its durability on fabric gloves on the touch screen of smartphones and tablets. Graphite paste that is conductor will convert the insulator fabric into a conductor, the washing resistance of graphite-polyurethane coatings that are different with graphite content between 25% and 33%. Conductive layers cannot be optimized without the knowledge of the planned application (Schäl *et al.,* 2018).

The purpose of this article is to find out whether or not fabrics that have been given graphite paste become a tool to touch the touchscreens of smartphones and tablets; and to find out how to keep graphite paste on touch screen gloves does not wear off when washed. The use of binders with a certain concentration can maintain microcapsules on the surface of the fabric after repeated washing. But when using a binder, hot air is needed so that the binder can form a layer on the fabric surface. The first step in making alginates is to convert insoluble calcium alginate and magnesium alginate into water-soluble sodium alginate with ion-exchange under alkaline conditions. Alginate is a natural polysaccharide commonly found in the cell walls of all species of brown algae (*Phaeophyceae*). Alginic acid was first patented by a chemist from Stanford England in 1881 by extracting Lamanaria stenophylla. The use of binders with a certain concentration can maintain microcapsules on the surface of the fabric after repeated washing. But when using a binder, hot air is needed so that the binder can form a layer on the fabric surface. Based on the problems that are happening, the researcher makes the research questions, what is the effect of graphite and its durability attached to the glove on the smartphones and tablets touch screen.

2. METHODS

The review study was conducted to find out characteristics of graphite, alginate, and polyacrylate which helps to find out whether or not a cloth that has been given graphite paste can be used as a tool to touch the touch screen of smartphones and tablets as well as how long the household washing resistance. Then state the criteria of the paper selection documents were collected from the international reputable journals and open access, from the year 2010 to 2020, regarding the specific topic on chemical substances which are conductor, thickener, binder, graphite, alginate, polyacrylate to be applied to cloth gloves. Based on the PRISMA protocol (Preferred Reporting Items for Systematic Review and Meta-

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analysis), PRISMA provides as many as 27 checklists in writing a systematic review. The author's experimental methods use the working procedure of the research is to heat the ultrapure water (**Figure 1)**, then dissolve the alginate slowly (**Figure 2**), mix the graphite, and stir evenly to make graphite paste (**Figure 3**). Then divide into 2 parts, one with polyacrylate in right glove, one part the other without polyacrylate in left glove. Then oven at 100^0C for 3 minutes until dry **figure 4**. Then test on a touch screen smartphone, and finally wash the gloves if it has been used to find out the washing power, then analysis.

Figure 1. A photograph image of ultrapure water being heated.

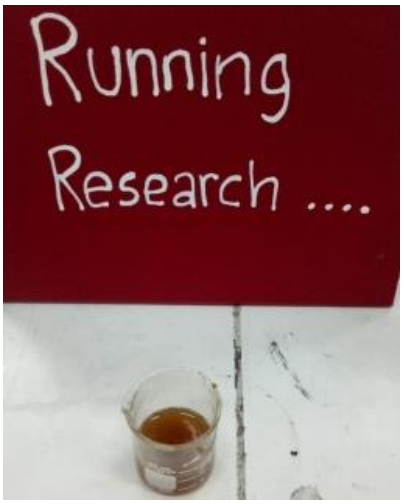

Figure 2. A photograph image of a mixture of alginate and ultrapure water.

Figure 3. A photograph image of graphite paste.

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Figure 4. A photograph image of the oven the gloves.

3. RESULTS AND DISCUSSION

3.1. Comparison of Gloves Without Graphite Paste and Gloves with Graphite Paste

Based on the presence or absence of conductive graphite content on gloves, graphite paste-fed gloves can be used to operate the touchscreen of a smartphone or tablet, while gloves without graphite paste cannot be used to operate the touchscreens of smartphones and tablets. Graphite paste that is conductor will convert the insulator fabric into a conductor, the washing resistance of graphite-polyurethane coatings that are different with graphite content between 25% and 33%. Conductive layers cannot be optimized without the knowledge of the planned application (Schäl *et al*.,2018). Natural graphite is carbon that has a crystal structure composed of carbon atoms that form a 3-dimensional (3D) structure. This material can be found in the contents of pencils that are often used for writing. When writing, the graphite will be brittle and make a simpler type of material known as graphene. Natural graphite is also one of the promising candidates as a lithium battery anode due to its low cost, low electrical potential, higher energy density, and relatively high reversible capacity (330-3500 mAh/g). Graphite paste uses ultrapure water as a solvent. The effectiveness and efficiency of the extraction process are largely determined by the type of solvent used because it contains different polarity indexes (Do *et al*.,2018). Aquadest and NaCl 0.9% which are water-based solvents have a better solubility effect than carboglycerin 10% and sodium docate 0.5% (Dharmaratne, G. S.,2020).

Synthetic graphite has the same properties as natural graphite. In addition, graphite synthesis has high purity, has a structure suitable for the process of intercalation and intercalation of lithium ions. However, graphite synthesis has a disadvantage in that the crystal structure is amorphous in shape so that to make it have a crystal structure at a high cost because it requires treatment at the temperature (>2,800^{o}C) in the graphitization process. Graphite can conduct electricity due to the large electron delocalization in the carbon layer (a phenomenon called aromaticity). These valence electrons are free to move, to conduct electricity. However, this electricity is mainly done in the layer field. The conductive properties of graphite powder allowed it to be used as a semiconductor replacement at the beginning of carbon microphones. The capacitive panel must be touched using a human finger or something that is composed of a conductive material. Electrically conductive textiles have been developed for various applications, such as textile-based wearable sensors, static charge

dissipation, electro-magnetic Interference shields (Bae, J *et al*.,2013). Graphite powder and graphite are rated in industrial applications for self-lubricating and dry lubricant properties. The combination of textiles and conductive inks makes it possible to produce conductive, lightweight, practical, and comfortable. the values of square resistance before and after washing for conductive ink Electrodag PF 410 (0.032 – 0.171 Ω/sq) were higher than those for conductive ink 5025 (0.010 – 0.074 Ω/sq) (Kazani, I *et al*.,2012).

Alginate is a type of material contained by *Phaeophyceae*, known in the world of industry and commerce for its many benefits. In the industrial world, alginate is in the form of alginic acid or alginate. Alginic acid is a membrane mucilage, while alginate is the salt form of alginic acid. Alginate can be extracted from brown seaweed (*Phaeophyceae*), e.g. Ascepyllum, Laminaria, Macrocystis, and Sargassum sp. Chemically, alginate is a pure polymer of ionic acid arranged in the form of long linear chains. There are two types of monomers that make up alginate, namely β-D-Mannopyranosil Uronat and Gulopyranosyl Uronat. In this practicum is used seaweed type Sargassum sp. to extract the alginate. Alginate fiber taken from the ocean having rich renewable resources environmental protection features opens a new and important source of fiber (Yu, X *et al*.,2013). Analysis of alginate quality in the form of yield, water content, ash levels, sulfate levels, and viscosity. The yield of a product is very important to know how much effect the treatment and processing of the result of a product. The yield of Na-alginate of 10.5% is higher than the yield value of K-alginate which only reaches 9.67%, but the yield obtained is still smaller than the international quality standard which reached 18%. The low yield is thought to be due to damage to alginate salts during the process. The process of discoloration causes the pigment to oxidize and degrade. Alginate yield is also influenced by several other factors such as species, climate, extraction methods, harvesting time.

Electro-conductive textiles can be prepared by using in-situ chemical, electro-chemical, and vapor phase polymerization processes (Kaynak *et al*., 2011). Viscosity is an important quality factor for liquids and semi-liquids (viscous), it is a measure and control to know the quality of the final product. The viscosity of hydrocolloids is influenced by several factors including concentration and temperature. the higher the drying temperature the viscosity value the higher. It is suspected that the increase in drying temperature will increase the formation of the number of sulfate esters so that the viscosity increases. Alginate is air soluble and thickens (colloidal solution), insoluble in alcohol, and insoluble in chlorine, ether, and acid with a pH of less than 3. Air-soluble alginates form gels in acidic solutions due to the presence of calcium ions or other polyvalent metal cations. Returning cations more than 35% with the cations will stop, molecular shifts, and a stable gel structure is formed. Low concentrations do not cause changes in shear and form gels, while high amounts of Ca cause high changes and form calcium alginate gels. So that alginate dissolved in water is a solvent of powder/solids that have undergone distillation that aims to eliminate the mineral content in the water so that pure water and equates can be used for laboratory purposes, after slowly alginate is dissolved in water and then added with graphite, with the intention that graphite becomes a paste and thickens so that it is easy to put on the sample glove, then sample in the oven or dry, with the optimum temperature of alginate is 60^0C. the exchange current density with temperature elevated from 20^0C to 60^0C can make anodic oxidation on graphite electrode proceeds faster at higher temperature (Smith *et al*.,2015).

3.2. Comparison of Polyacrylate Gloves and Gloves Without Polyacrylate

In **Figure 5**, the sample image is shown based on the presence or absence of polyathane content. Graphite paste plus polyacrylate is not easily weathered when exposed to high

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temperatures and does not easily fade when washed. Meanwhile, graphite paste without polyacrylate is easily weathered when exposed to high temperatures and easily fades when washing.

One of the processes to improve the function of cotton fabric is refinement with microcapsule. The microcapsule is expected to have adequate resistance on the surface of cotton fabric. But because microcapsules tappers do not bind chemically to cotton cloth, binders are used such as polyacrylate and polyurethane. This research aims to study the effectiveness of polyacrylate-based binders and polyurethane on the microcapsule refinement of cotton fabric using padding techniques. The cotton fabric that was the result of microcapsule refinement observed its surface with the Scanning Electron Microscope (SEM), tested its washing resistance with launder-O-meter, its tensile strength with tensile tester, and its rigidity with stiffness tester. Microcapsules are further analyzed particle size using Particle Size Analyzer (PSA) and the type of pad using Fourier Transform Infra-Red (FTIR). The results showed that the average size of the microcapsule is 1.14 µm, polyacrylate binders and polyurethane can maintain microcapsules on the surface of cotton cloth up to the equivalent of 10-50 times household washing. Microcapsuling pads are generally unreactive so they cannot chemically bond to the fabric but still allow aggregation between microcapsules. To increase mechanical strength, such as microcapsules resistance to washing, it can be done through several ways including choosing application techniques, auxiliary substances, and suitable eavesdropping materials. Auxiliary substances that can be used to increase the resistance of microcapsules in fabrics to mechanical treatment are cross-linking agents and binders. 1,2,3,4-butane tetracarboxylic acid (BTCA) can be used as a cross-linking agent but is inefficient whereas binders are usually made of polyacrylate, adding polyacrylate to alginate paste and graphite, can affect the connective power of the fabric. Microcapsules can still survive on the surface of cotton cloth after washing equivalent to 5 to 10 times household washing with a polyacrylate-based binder (Aracil *et al.,* 2016).

Figure 5. The right glove is graphite paste with polyacrylate and the left glove is graphite paste without polyacrylate

The use of binders with a certain concentration can maintain microcapsules on the surface of the fabric after repeated washing. But when using a binder, hot air is needed so that the binder can form a layer on the surface of the fabric. Polyacrylates are the category of polymers that raise most the stiffness and hardness of fabric, compared to aliphatic

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polyurethanes, retaining the effect and after washing, in the aggregate polyurethanes almost on the same level, without a remarkable difference compared to untreated fabric regarding tear resistance. Influences warp tear in such a way that runs the risk to approach 3200 grams of tear strength (Giannoulis, A *et al,.2016)*. States that the microcapsule resistance of the fabric to washing depends on the concentration of binders and hot air used. Binders can form a layer on the surface of the fabric with the help of hot air when curing. The layer holds the microcapsule to remain on the surface of the fabric, the surface of the fabric becomes thicker so that the tensile strength increases. So, adding the use of polyacrylate-based binders can maintain microcapsules on the surface of cotton cloth up to the equivalent of 10-50 times household washing, and increase tensile strength. F**igure 6** shows a glove that has been washed 50 times in household washing, the graphite paste gloves without polyacrylate on the left of the glove have faded and the graphite paste gloves with polyacrylate on the right still have a paste.

Figure 6. Gloves that have been washed 50 times in the household

4. CONCLUSION

The conclusion from this article is that the manufacture of alginate paste with graphite can turn insulator gloves into conductors, and can be used as gloves that are sensitive to the touch screen of smartphones and tablets. Also, the addition of a polyacrylate-based binder can bind and make graphite paste resistant to washing 10-50 times household washing.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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