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Effect of mixed nanoparticles ZnS and polyvinyl alcohol (PVA) against nanocomposite mechanical properties of PVA / ZnS

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Abstract: This study was conducted to see the effect of a mixture of ZnS nanoparticles and PVA on the properties of nanocomposite PV / ZnS. Mixing is done with the sol-gel method, which dissolve ZnS nanoparticles and PVA with distilled water. Stirring is done through the magnet, with the angular velocity of 500 rpm, and heated at 80 ° C temperature. The solution that has been shaped gel then put into molds and then cooled naturally. Variations mixture of PVA: ZnS is (100:0)%, (99:1)%, (98:2)%, (97:3)% and (96:4)%. The results of mechanical tests showed that the average maximum tensile strength of 34.390 MPa obtained on the composition of the mixture of PVA: ZnS at (100:0)%, the average maximum elongation at break of 430.81% was obtained on the composition of the mixture of PVA: ZnS at (99 : 1)%, the average elastic modulus of 190.73 MPa maximum obtained on the composition of the mixture of PVA: ZnS at (98:2)%. This result is better because it is more equitable in terms of mixing and content conforms to the crosslinking better. DSC results obtained on the composition of the maximum melting temperature of PVA: ZnS at (97:3)% which is at a temperature of 224.39 ℃.

Keywords: Nanocomposite, PVA, ZnS, Mechanical, Thermal

1. Introduction

Nanotechnology is the engineering science that can change the material properties. Nanoparticles have a ratio between surface area and volume of a larger, this makes the nanoparticles are more reactive. Reactivity of the material is determined by the atoms on the surface, because only these atoms are in direct contact with another material. Application of nanotechnology used in many fields including high-resolution screen, creating an anti-stain clothing, health and automotive areas [1,2].

Nanoparticles used to prevent fouling on clothing, where the feathers glued surface with nano size so similar to taro leaf surface . Polymer nano sizes ranging from 10 nm to 100 nm is used for exterior wall paint, adhesives, paper coatings, upholstery fabrics, as well as retaining cosmetic UV rays, as well as retaining the light of the sun. With its small size is then dispersed and can absorb UV rays. Nanoparticles of aluminum used to mix propellant (fuel) that is able to accelerate the burning of up to two-fold. Nanocopper mixed in the lubricating oil to prevent engine wear .Nanocalcium and phosphate composites used as synthetic bone. The advantages of using composites are lightweight, corrosion resistance, longer service life and high elasticity properties. Application of semiconductor nanoparticle technology in particular has been widely used in biology and biomedicine. Compound semiconductor nanoscale dimensions can be used as sensors for cells of the human body, because it is able to detect the cancer so that treatment can be more effective [3,4,5,6,7,8].

Polyvinyl alcohol (PVA) is one type of hydrophilic polymer. This material is widely used in the fields of chemistry, pharmaceuticals and healthcare. PVA can be mixed with other materials to get a better composite according to its usefulness. Reference [9] has been mixing PVA with bacterial cellulose. Reference [10] mixing PVA with silver (Ag) to get a higher conductivity properties. Reference [11] adds graphene oxide on the PVA to produce a composite that has high tensile strength . The products produced as a result of this process generally has good physical properties , non-toxic and have the ability to absorb the relatively high water and biocompatible [12]. Crosslinked PVA hydrogel (crosslink) is one of the PVA polymer modified. The hydrogel has a three-dimensional network structure which allows the inclusion of other substances intoit. Therefore hydrogel matrix is widely used for immobilizing drugs, cells, enzymes, and polysaccharides [13].

PVA hydrogel is one type of hydrogel developed for applications in the fields of chemistry and health and biomedicine. These hydrogels have unique properties, which has a transition temperature of 58oC to 85oC and the degree of hydrolysis of partially filled with a degree of hydrolysis. Since the melting point of PVA is relatively low, it would require an amplifier that can improve the physical properties of the material. PVA is also sensitive to temperature, so it needs to be modified as new material.

2. Methods

To create a nanocomposite PVA / ZnS used sol-gel method. PVA weighing 20 g dissolved in 200 ml of distilled water and stirred using a magnetic stirrer while heated with a hot plate. ZnS nanoparticles weighing 0.2 g (1 % by weight) was dissolved in 200 ml of distilled water, and stirred until dissolved. Both of these solutions incorporated into the three-neck flask and stirred using a magnetic stirrer with a speed of 500 rpm while heated with a hot plate to a temperature of 80oC. After distilled water solution evaporates and thickens like a gel, then put into a mold that has formed from glass , and allowed to dry and harden. This procedure is repeated with variations PVA : ZnS , namely (100 : 0)%, (99:1)%, (98:2)%, (97:3)%, and (96:4)%. According to reference [14], the weight percentage of nano- particulate inserted is a very small about 0.5 % to 5 %. Samples were formed according to the sample test , tensile test to ISO 527-2 and ASTM D3418 Test with a DSC- 03. Scanning Electron Microscopy (SEM) to determine the morphology of the surface of the sample and EDS to determine the content of the elements that exist in the nanocomposite is formed.

3. Results and Discussion

Nanocomposite PVA / ZnS have been synthesized by sol-gel method. Formed according to the results of tensile testing ISO 527-2 with a length of 26 mm, 4 mm wide and 1.124 mm thick, as shown in Figure 1.

Figure 1. Sampel for tensile test with a mixture of PVA and ZnS nanoparticles (PVA: ZnS); S1 (100:0)% and S2 (99:1)%.

Shown in Figure 1.variation of each sample was made 5 pieces to get a more accurate result and the results averaged measurements taken. Sample S1 with only PVA (ZnS nanoparticle 0%) have clear and transparent colors. Sample S2 with a mixture of PVA and variations ZnS nanoparticles (99:1)% has a white color somewhat darker than the sample S1. With a mixture of 1% ZnS nanoparticles have shown differences in terms of color samples, as well as for samples with a mixture of PVA and ZnS nanoparticles (98:2)%, (97:3)% and (96:4)%. They have more white color and not transparent. This is due to the amount of nanoparticles are mixed more and more.

To determine the tensile strength, tensile test performed on elongation at break, strain and Young's modulus. Testing conducted by UCT tensile test for variation 5 mix between PVA and ZnS nanoparticles. Records of the results of tensile tests nanocomposite PVA / ZnS nanoparticles to a mixture of PVA and ZnS is like Figure 2.

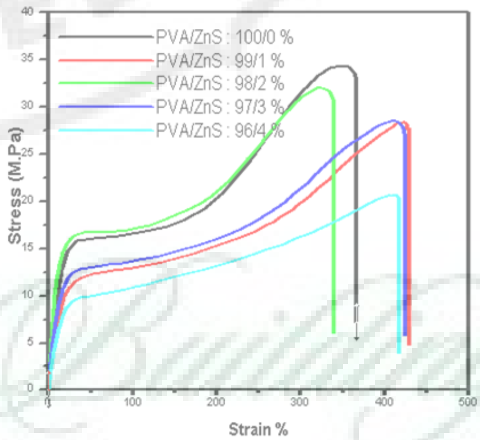

Figure 2. Graph of stress to strain the relationship between the composition of a mixture of several PVA and ZnS nanoparticles.

Maximum tensile strength test results, maximum strain, elongation at break and Young's modulus of the nanocomposite PVA / ZnS for composition (100:0)%, (99:1)%, (98:2)%, (97:3)% and (96:4)% can be seen in Table 1.

Table 1. *Data Tensile Strength Testing Results, Extension Disconnect and Young's modulus of the mixture of PVA and ZnS nanoparticles.*

Sample	26 mm long 4 mm width Thickness(mm)	Composition of nanoparticles (% wt)	$\overline{\sigma}_{max}$ (MPa)	$\overline{\varepsilon}_{max}$ (%)	$\overline{E}_{max}$ (MPa)
S1	(1,124±0,112)	100 : 0	34,390	361,75	153,84
S2	(1,313±0,053)	99 : 1	28,747	430,81	106,30
S3	(1,264±0,091)	98 : 2	32,536	326,00	190,73
S4	(1,483±0,069)	97 : 3	28,137	415,19	120,52
S5	(1,200±0,063)	96 : 4	19,987	401,49	87,04

Figure 2 and Table 1 shows the relationship between the stress to strain of ZnS nanoparticles compositions obtained from the tensile test. Provided that the greatest tensile strength of the nanocomposite PVA / ZnS for the composition of 0 % and a maximum strain present in the nanocomposite PVA / ZnS for the composition of the 1 % . The greater the voltage composition ZnS nanoparticles smaller. Not miscible polymer blend (immiscible blend) has the physical tension between the weak component at the phase boundary, which can cause phase separation in certain conditions and cause the mechanical properties of the mixture becomes less good [15, 16]. For the more strain the mixture is obtained that the ZnS nanoparticles in general the greater the strain. Special to the mixture of 2% ZnS nanoparticles obtained the largest strain 430.81 %. The largest Young's modulus obtained on the composition of PVA :ZnS (98:2) % which is 190.73 MPa. Modulus is influenced by stress and strain. The greater the voltage owned the Young's modulus greater. And the greater the strain possessed a Young's modulus smaller. So the composition of the mixture is obtained ZnS 2 % greater voltage and smaller strain. The addition of 2 % ZnS will multiply the number of cross-linking (cross-linking) between the molecular chains that affect mechanical properties. PVA with a little amount of crosslinking will be relatively soft and flexible with the amount of the PVA crosslinking more[1, 17].

To determine the melting temperature of the nanocomposite PVA / ZnS thermal test using diferential scanning calorimetry(DSC) . DSC analysis with a mass of 6.8 mg using nitrogen gas with a flow rate of 20 cc / min and the heating rate was 20 ° C / min. For the nanocomposite sample variation between PVA and ZnS mixture (100:0) % , (99:1) % , (98:2) % , (97:3) % and (96:4) % , obtained thermogram results as Table 2.

Table 2. *Thermal Data Testing Results nanocomposite PVA / ZnS*

Sample (PVA:ZnS)%	Peak Tm(°C)	Entalpi ΔH(J/g)	Heat ΔQ (mJ)
S1 (100:0)	222,78	20,7456	141,070
S2 (99:1)	223,33	23,6269	212,642
S3 (98:2)	221,47	20,8009	139,366
S4 (97:3)	224,39	15,1036	93,642
S5 (96:4)	221,40	26,0826	148,671

From Table 2 it can be seen that in general the addition of nanoparticles gives rise from the melting temperature, but in the nanocomposite mixture of PVA / ZnS (98: 2)% and (96:4)% down. It can be caused by uneven mixture of nanoparticles and also the process of making that less than the maximum, in terms of mixing and drying. Greatest value of the melting temperature of the mixture contained in the nanocomposite PVA / ZnS in composition (97:3)%ie 224.39 °C.

4. Conclusions and Recommendations

Preparation of nanocomposite Polyvinyl Alcohol (PVA) with a mixture of PVA and the composition of ZnS nanoparticles of 0 % , 1 % , 2 % , 3 % and 4 % concluded that the results of mechanical tests nanocomposite PVA / ZnS nanoparticles to a mixture of PVA and the composition ZnS (98:2) % gained an average of the largest Young's modulus , which is 190.73 MPa . Average elongation at break occurred in a mixture of PVA and 1 % ZnS nanoparticles is 430.81 % and the average maximum tensile strength occurs at a mixture of PVA and 0 % ZnS nanoparticles is 34.390 MPa.

Thermal test results nanocomposite PVA / ZnS nanoparticles to a mixture of PVA and the composition ZnS (97:3) % obtained the largest melting temperature is 224.39 ° C with enthalpy 15.1036 J / g and the heat of 93.642 mJ.Effect of the addition of ZnS nanoparticles can be developed further to see other properties of the nanocomposite PVA / ZnS , such as optical properties , hardness properties that can improve the economic and functional value of PVA / ZnS . In the manufacture of nanocomposite PVA / ZnS note stirring process and temperature stability so that a mixture of ZnS nanoparticles and PVA can be mixed well and evenly .

References

[1] Mancini,L.H., dan Esposito, C.L., (2008), Nanocomposites : Preparation, Properties and Performance, Nova Science Publisher, Inc, New York.

[2] Kumar, A.P., DilipDepan, Namrata Singh Tomer, Raj Pal Singh, (2009), Nanoscale particles for Polymer Degradation and Stabilization- Trends and Future Perspectives, Progres in Polymer Science, 34, p.479-515.

[3] Chang, J.Y.; Godovsky,D.Y.; Han, M.J.; Hassan, C.M; Kim, J.; Lee, B; Lee, Y; Peppas, N.A.; Quirk, R.P; Yoo, T., (2000), Biopolymers PVA Hydrogels Anionic PolymerisationNanocomposites, Springer-Verlag Berlin Heidelberg.

[4] Bielecki, S., Krystinowicz, A., Turkiewcz, M. B. C., Kalinowska, H. (2005), Bacterial cellulose, in: Polysaccharides and polyamide in the food industry: Properties, production and patents, Wiley VCH, Weinhein.

[5] Bhushan, B., (2007),Handbook of Nanotechnology, Springer Science+Business Media, Inc. New York.

[6] Busnaina, A.,(2007), Nanomanufacturing Handbook, CRC Press, New York.

[7] Mikrajuddin, A., (2008), Introduction to Nanoscience(PengantarNanosains), ITB, Bandung.

[8] Gogotsi, Y., (2006), Nanomaterials Handbook, Taylor & Francis Group, New York.

[9] Gea, S, (2010), Innovative Bio-nanocomposites Based on Bacterial Cellulose, Thesis Doctor, Queen Mary University of London.

[10] Campos, J.B., Prokhorov, E., Sanchez, I.C., Barcenas, J.G.L, Ramirez, A.M, Hernandez, J.G., Castro, Y.L., Rio, R.E., 2012, Molecular Dynamics Analysis of PVA-AgnP Composites by Dielectric Spectroscopy, Journal of Nanomaterial, vol. 2012.

[11] Zhang, L,.Zhipeng Wang, Chen Xu, Yi Li, JianpingGao, Wei Wang and Yu Liu, (2011), High Strength Graphene Oxide/Polyvinyl Alcohol Composite hydrogels, Journal of Materials Chemistry, 21, p.10399-10406.

[12] Sun, P., Chen, J., Liu Z, W., Liu, Z , T. (2009). Poly(vinyl Alcohol) Functionalized β-cyclodextrin as an Incluion Complex. Journal of Macromolecular Science, Part A: Pure and Applied Chemistry, 46, 533-540.

[13] ErizaldanRahayu, 2009, Thermo-Responsive Hidrogel of Polyvinyl Alcohol (PVA)-Co-N-Isoprovyl Acrylamide (NIPAAM) Prepared by- γ Radiation as a Matrix Pumping/On-Off System, Indo.J. Chem.9 (1) : 19-27.

[14] Mikrajuddin, A., Virgus, Y., NirmindanKhairurrijal, (2008), Review: Sintesis Nanomaterial, JurnalNanosains&Nanoteknologi, Vol. 1, No.2.

[15] Utracki, L.A.,(1999), Polypropylene Blends with Elastomers, In : Karger-Koccis,K. Polypropylene : A-Z Reference. Dordrecht:Kluwer Publishers.

[16] Deborah D.L. Chung, 2010, Composite Materials Science and Applications, Springer London Dordrecht Heidelberg NewYork.

[17] Saptono, R., 2008, Materials Science, Department of metallurgy and Materials Engineering Faculty of UI (IlmuPengetahuanBahan, Departemen of Metallurgi and Material FakultasTeknik UI).