“PENGARUH WAKTU REAKSI PADA SINTESIS *POLYDIMETHYLSILOXANE* (PDMS) MENGGUNAKAN TEKNIK *RING OPENING POLYMERIZATION* TERHADAP KESTABILAN SIFAT MATERIAL”

SKRIPSI

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar Sarjana Sains

Program Studi Fisika Departemen Pendidikan Fisika

kelompok bidang kajian Fisika Material

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UNIVERSITAS PENDIDIKAN INDONESIA

2021

PENGARUH WAKTU REAKSI PADA SINTESIS *POLYDIMETHYLSILOXANE* (PDMS) MENGGUNAKAN TEKNIK *RING OPENING POLYMERIZATION* TERHADAP KESTABILAN SIFAT MATERIAL

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ABSTRAK

Polydimethylsiloxane (PDMS) merupakan cairan pengganti *vitreous humour* pada operasi vitreoretinal untuk penyembuhan ablasio retina yang keberadaannya dibutuhkan di Indonesia. *Polydimethylsiloxane* (PDMS) memiliki sifat inert, transparan, dan diketahui memiliki stabilitas yang tinggi. Sintesis sampel PDMS dengan *scale-up* berhasil dilakukan melalui teknik sintesis *ring opening polymerization.* Proses sintesis didukung oleh *octamethycyclotetralsiloxane* (D4) sebagai monomer dan *hexamethyldisiloxane* (MM) sebagai terminator. KOH dengan konsentrasi sebesar 0,75 M pada proses sintesis digunakan sebagai inisiator. Waktu sintesis untuk PDMS yaitu 35 menit dan 20 menit masing-masing untuk PDMS-1 dan PDMS-2. Sedangkan suhu reaksi adalah 150 ℃. PDMS yang dihasilkan dari proses sintesis bersifat bening, kental, dan tidak berbau yang menandakan bahwa proses sintesis berhasil dan sisa kloroform sudah hilang. Untuk menentukan stabilitas sifat fisis PDMS, pada penelitian ini uji stabilitas pada PDMS hasil sintesis dilakukan selama satu bulan di ruang penyimpanan pada suhu ruang. Sifat fisis PDMS yang meliputi gugus fungsi, viskositas, tegangan permukaan, indeks bias, dan transmitansi diperiksa setiap minggu dalam kurun waktu satu bulan. Hasil uji stabilitas viskositas dan tegangan permukaan menunjukkan bahwa nilai viskositas dan tegangan permukaan PDMS-2 memiliki kestabilan yang lebih baik. Uji stabilitas sifat optik yang meliputi indeks bias dan transmitansi menunjukkan bahwa PDMS-1 dan PDMS-2 mengalami penurunan. Hasil FTIR seluruh sampel PDMS menunjukkan PDMS memiliki gugus fungsi yang sama seperti PDMS komersial setelah penyimpanan selama satu bulan. Secara keseluruhan, viskositas, tegangan permukaan, dan gugus fungsi PDMS-2 relatif lebih stabil dari PDMS-1. Sedangkan sifat optik PDMS terutama transmitansi belum menunjukkan nilai yang stabil karena transmitansi PDMS terus menurun selama masa penyimpanan. Secara keseluruhan, PDMS-2 dengan waktu reaksi 20 menit memiliki nilai kestabilan lebih baik dari PDMS-1 dengan waktu reasi 35 menit.

Kata Kunci : *Polydimethysiloxane*, Waktu Reaksi, Stabilitas Material, *Vitreous Humour*

EFFECT OF REACTION TIME ON SYNTHESIS OF POLYDIMETHYLSILOXANE (PDMS) USING RING OPENING POLYMERIZATION METHOD ON THE STABILITY OF MATERIAL PROPERTIES

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ABSTRAC

Polydimethylsiloxane (PDMS) is a replacement for vitreous humor in vitreoretinal surgery for retinal detachment treatment which is needed in Indonesia. Polydimethylsiloxane (PDMS) is inert, transparent, and is known to have high stability. The synthesis of PDMS samples with scale-up was successfully carried out through the ring opening polymerization synthesis technique. The synthesis process was supported by octamethycyclotetralsiloxane (D4) as the monomer and hexamethyldisiloxane (MM) as the terminator. KOH with a concentration of 0.75 M in the synthesis process was used as an initiator. The synthesis time for PDMS was 35 minutes and 20 minutes for PDMS-1 and PDMS-2, respectively. While the reaction temperature is 150 ℃. PDMS produced from the synthesis process is clear, viscous, and odorless which indicates that the synthesis process was successful and the remaining chloroform has disappeared. To determine the stability of the physical properties of PDMS, in this study the stability test on the synthesized PDMS was carried out for one month in a storage room at room temperature. The physical properties of PDMS which include functional groups, viscosity, surface tension, refractive index, and transmittance are checked every week for one month. The results of the viscosity and surface tension stability test showed that the viscosity and surface tension values of PDMS-2 had better stability. Stability test of optical properties which include refractive index and transmittance showed that PDMS-1 and PDMS-2 decreased. The FTIR results of all PDMS samples showed that PDMS had the same functional groups as commercial PDMS after one month of storage. Overall, the viscosity, surface tension, and functional groups of PDMS-2 are relatively more stable than PDMS-1. While the optical properties of PDMS, especially transmittance, have not shown a stable value because the transmittance of PDMS continues to decrease during the storage period. Overall, PDMS-2 with a reaction time of 20 minutes has a better stability value than PDMS-1 with a reaction time of 35 minutes.

Keywords : Polydimethylsiloxane, Reaction Time, Material Stability, Vitreous Humour

DAFTAR ISI

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DAFTAR TABEL

DAFTAR PUSTAKA

Admadi H, B., & Arnata, I. W. (2015). *Teknologi Polimer*. 1–46.

Barca, F., Caporossi, T., & Rizzo, S. (2014). Silicone oil: Different physical proprieties and clinical applications. *BioMed Research International*, *2014*. https://doi.org/10.1155/2014/502143

Bayu, A., Nandiyanto, D., Oktiani, R., & Ragadhita, R. (2019). *Indonesian Journal of Science & Technology How to Read and Interpret FTIR Spectroscope of Organic Material*. *1*, 97–118.

Belwal, S., Revanth, V., Dinesh, K. S. V. V, Reddy, B. V, & Rao, M. B. (2016). Development and Scale Up Of a Chemical Process in Pharmaceutical Industry: A Case Study. *Journal of Engineering Research and Application Www.Ijera.Com*, *6*(2), 81–88. www.ijera.com

Caro, C. A. De, & Claudia, H. (2017). *UV / VIS Spectrophotometry*. *November*.

Chung, D. D. L. (2001). Applied Materials Science. In *Applied Materials Science* (Issue June 2001). https://doi.org/10.1201/9781420040975

Esteves, R., Dikici, B., Lehman, M., Mazumder, Q., & Onukwuba, N. (2016). Aqueous Surfactant Solution Surface Tensions with a Surface Tensiometer. *Beyond: Undergraduate Research Journal*, *1*(January), 4. https://commons.erau.edu/beyond

Fitrilawati, Fauza, A. N., Ardi, A., Novianti, R. M., Syakir, N., Kartasasmita, A. S., & Risdiana. (2018). Effect of KOH concentration on characteristics of polydimethylsiloxane synthesized by ring opening polymerization method. *Journal of Physics: Conference Series*, *1080*(1), 1–7. https://doi.org/10.1088/1742-6596/1080/1/012016

Francis PJ, J. (2018). Biomedical Applications of Polymers -An Overview. *Current Trends in Biomedical Engineering & Biosciences*, *15*(2), 44–45. https://doi.org/10.19080/ctbeb.2018.15.555909

Giancoli, D. C. (1991). Principles with applications. In *ReCALL*.

https://doi.org/10.1017/CBO9781107415324.004

Giordano, G. G., & Refojo, M. F. (1998). Silicone oils as vitreous substitutes. *Progress in Polymer Science (Oxford)*, *23*(3), 509–532. https://doi.org/10.1016/S0079-6700(97)00046-4

Hartanto, W., & Inakawati, S. (2010). Kelainan Refraksi Tak Terkoreksi Penuh di RSUP dr. Kariadi Semarang. *Media Medika Muda*, *4*, 25–30.

Heath, D. E., & Cooper, S. L. (2013). Polymers: Basic Principles. *Biomaterials Science: An Introduction to Materials: Third Edition, December 2013*, 64–79. https://doi.org/10.1016/B978-0-08-087780-8.00008-5

Indrawati, T., Sari, N. K., Farmasi, P. S., Sains, I., Selatan, J., & Pembahasan, H. (2010). *KELEMBABAN RUANG PENYIMPANAN YANG BERBEDA Metode Penelitian*. *14*(2), 75–80.

Juniarta, I. K., Wirawan, I. K. G., & Ghurri, A. (2017). Studi Eksperimental Pengaruh Variasi Tekanan Terhadap Sudut Semburan Minyak Jelantah. *Jurnal Ilmiah TEKNIK DESAIN MEKANIKA*, *6*(2), 215–219. https://ojs.unud.ac.id/index.php/mekanika/article/view/34404

Kartasasmita, A., Kusdiono, W., Virgana, R., & Boesorie, S. (2017). <i>In Vivo</i> Emulsification Analysis of 1000 cs and 5000 cs Silicone Oil after Rhegmatogenous Retinal Detachment Vitrectomy Surgery. *Open Journal of Ophthalmology*, *07*(04), 231–239. https://doi.org/10.4236/ojoph.2017.74031

Kausar Shafaat, Afzal Hussain, Brajesh Kumar, Rizwan ul Hasan, P. P. V. K. Y. (2013). AN OVERVIEW : Storage of pharmaceutical products an overview. *World Journal of Pharmacy and Pharmaceutical Sciences*, *2*(5), 2499–2515.

Kholifiyah, S. N. (2020). *Pengaruh Temperatur Sintesis Terhadap Karakteristik Polydimethysiloxane (PDMS) yang Dibuat dengan Teknik Ring Opening Polymerization (ROP)*. http://repositorio.unan.edu.ni/2986/1/5624.pdf

Khurana, A. K. (2007). *Comprehenisive Ophthalmology*. (fourth). New Age International (P) limited, Publishers.

Setiadji, S. (2019).*"*Uji Stabilias Bahan Polydimethylsiloxane*" Jurnal Material dan Energi Indonesia., vol. 09, no. 01, pp. 8–17, 2019. 09*(01), 8–17. doi: https://doi.org/10.24198/jmei.v9i1.23104

Koohyar, F. (2013). Refractive Index and Its Applications. *Journal of Thermodynamics & Catalysis*, *04*(02), 7544. https://doi.org/10.4172/2157-7544.1000e117

Kou, H., Li, W., Zhang, X., Xu, N., Zhang, X., Shao, J., Ma, J., Deng, Y., & Li, Y. (2019). Temperature-dependent coefficient of surface tension prediction model without arbitrary parameters. *Fluid Phase Equilibria*, *484*, 53–59. https://doi.org/10.1016/j.fluid.2018.11.024

Lakits, A. (1999). Chemical Stability of Silicone Oil in the Human Eye after Prolonged Clinical Use. *Journal: Ophthalmology*. *106*(6). 1091–1100. doi: 10.1016/S0161-6420(99)90261-0

Marcinkowski, Ł., Szepiński, E., Milewska, M. J., & Kloskowski, A. (2019). Density, sound velocity, viscosity, and refractive index of new morpholinium ionic liquids with amino acid-based anions: Effect of temperature, alkyl chain length, and anion. *Journal of Molecular Liquids*, *284*, 557–568. https://doi.org/10.1016/j.molliq.2019.04.026

Mata, A., Fleischman, A. J., & Roy, S. (2005). Characterization of Polydimethylsiloxane (PDMS) Properties for Biomedical Micro/Nanosystems. *Biomedical Microdevices*, *7*(4), 281–293. https://doi.org/10.1007/s10544-005-6070-2

Gungel. (2005). Fourier Transform Infrare and H Nuclear Magnetic Resonance Specstroscopic Findings of Silicone Oil Removed From Eyes and The Relationship of Emulsification with Retinotomy and Glaucoma. 332–338. doi: 10.1097/00006982-200504000-00013

Miller, J. B., Papakostas, T. D., & Vavvas, D. G. (2014). Complications of emulsified silicone oil after retinal detachment repair. *Seminars in Ophthalmology*, *29*(5–6), 312–318.

https://doi.org/10.3109/08820538.2014.962181

Mitomo, M., & Uenosono, S. (1991). Callister, William D. Materials Science and Engineering. Seventh Edition New York: John Wiley & Sons, Inc.2007. In *Journal of Materials Science* (Vol. 26, Issue 14). https://doi.org/10.1007/BF01184995

Monteiro, J. P., Santos, F. M., Rocha, A. S., Castro-de-Sousa, J. P., Queiroz, J. A., Passarinha, L. A., & Tomaz, C. T. (2015a). Vitreous humor in the pathologic scope: Insights from proteomic approaches. *Proteomics - Clinical Applications*, *9*(1–2), 187–202. https://doi.org/10.1002/prca.201400133

Monteiro, J. P., Santos, F. M., Rocha, A. S., Castro-de-Sousa, J. P., Queiroz, J. A., Passarinha, L. A., & Tomaz, C. T. (2015b). Vitreous humor in the pathologic scope: Insights from proteomic approaches. In *Proteomics - Clinical Applications*. https://doi.org/10.1002/prca.201400133

Munson, B. R., Young, D. F., Okiishi, T. H., & Huebsch, W. W. (2009). Fundamentals of Fluid Mechanics 6th Edition. *Fundamental of Fluids Mechanics*, 93–146. http://civilcafe.weebly.com/uploads/2/8/9/8/28985467/fluid_mechanics.pdf

Nusa, H. S., Astuti, W., Kartasasmita, A. S., Virgana, R., Syakir, N., Bahtiar, A., Safriani, L., & Risdiana. (2015). Characterization of optical and structure properties of polydimethylsiloxanes. *Materials Science Forum*, *827*, 99–104. https://doi.org/10.4028/www.scientific.net/MSF.827.99

Pantjawati, D., Iskandar, E., Virgana, R., Kartasasmita, A., & Sovani, I. (2017). Patient Characteristics And Outcome After Silicone Oil Removal At Cicendo Eye Hospital, April 2011 - March 2012. *Bali Journal of Ophthalmology*, *1*(1), 14–17. https://doi.org/10.15562/bjo.v1i1.4

Vaziri, K. (2016). Tamponade in the surgical management of retinal detachment. *Clinical Ophthalmology*. 471–476. doi: 10.2147/OPTH.S98529

Rahayu, A. T. (2020). *Sintesis dan Karakterisasi Sifat Fisis Polydimethysiloxane (PDMS) dengan Variasi Kalium Hidroksida sebagai Inisiator*.

http://repositorio.unan.edu.ni/2986/1/5624.pdf

Rahayu, A. T., & Kholifiyah, S. N. (2019). *Variasi waktu pencampuran terhadap karakteristik PMDS yang disintesis dengan polimerisasi adisi*. *0*, 436–441.

Rahayu, A. T., Kholifiyah, S. N., Fisika, P. S., Pendidikan, F., & Pengetahuan, I. (2019). *Sintesis dan karakterisasi polydhimetylsiloxine dengan teknik Ring-Opening Polymerization*. *0*, 306–310.

Saripudin, SPd, & MT. (2019). *Pedoman Penulisan Karya Ilmiah UPI Tahun 2015*.

Setiadji, S., Fitrilawati, Fauza, A. N., Ardi, A., Novianti, R. M., Syakir, N., Waslaluddin, Rahayu, I., Kartasasmita, A. S., & Risdiana. (2019). Optimization of polydimethylsiloxane synthesized parameters as vitreous humour substitutes. *Materials Science Forum*, *966 MSF*, 189–193. https://doi.org/10.4028/www.scientific.net/MSF.966.189

Shabrina, A. N., & Syahida, N. A. (2020). *Variasi Suhu Sintesis terhadap Karakteristik Fisis Polydimethysiloxane dengan Metode Ring Opening Polymerization*. *0*, 146–149.

Sovani, I. (1998). *Teknik Bakel Sklera Pada Ablasio Retina* (p. 3).

Stivala, S. S., & Reich, L. (1980). Structure vs stability in polymer degradation. *Polymer Engineering & Science*, *20*(10), 654–661. https://doi.org/10.1002/pen.760201003

Volkov, A. V. (2015). Encyclopedia of Membranes. *Encyclopedia of Membranes*, *08*, 1–3. https://doi.org/10.1007/978-3-642-40872-4

Wnek, G. (2015). *Polymers*. *October*. https://doi.org/10.1081/E-EBBE

Wong, S. C., Ramkissoon, Y. D., & Charteris, D. G. (2010). Rhegmatogenous retinal detachment. *Encyclopedia of the Eye*, *1*, 129–138. https://doi.org/10.1016/B978-0-12-374203-2.00265-7

Yan, S. R., Kalbasi, R., Nguyen, Q., & Karimipour, A. (2020). Sensitivity of adhesive and cohesive intermolecular forces to the incorporation of MWCNTs into liquid paraffin: Experimental study and modeling of surface tension.

Journal of Molecular Liquids, *310*, 113235. https://doi.org/10.1016/j.molliq.2020.113235

Zhu, J., Zhang, E., & Rio-Tsonis, K. (2012). Eye Anatomy. *ELS*, *October*. https://doi.org/10.1002/9780470015902.a0000108.pub2

Zwinkels, J. C., & Canada, C. (2020). Encyclopedia of Color Science and Technology. *Encyclopedia of Color Science and Technology*, *January 2015*. https://doi.org/10.1007/978-3-642-27851-8