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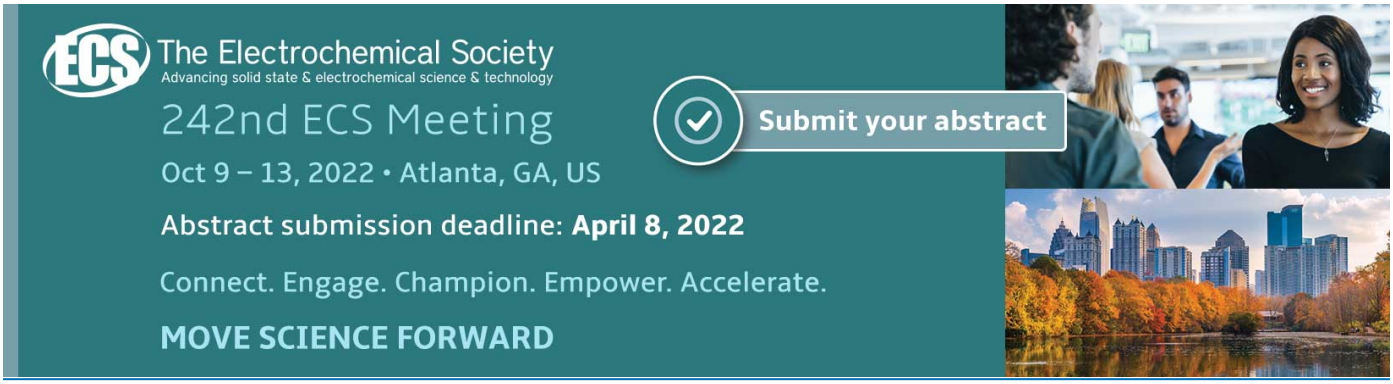

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Soedirman's International Conference on Mathematics and Applied Sciences
SICoMAS 2019
23-24 October 2019, Purwokerto, Indonesia

Report from The Organizing Committee

It is indeed my great pleasure and honor to welcome you all to Soedirman's International Conference on Mathematics and Applied Sciences (SICoMAS) 2019. The conference running this year is the first SICoMAS series hosted by Faculty of Mathematics and Natural Sciences Jenderal Soedirman University. As the development of technology and management of world resources for our future based on the innovation in Mathematics and Sciences, this conference takes issue "Innovation in Mathematics and Applied Sciences for better future".

SICoMAS 2019 aims to provide a platform for researchers, lecturers, teachers, students, practitioners, and industrial professionals to share knowledge, exchange ideas, collaborate, and present research results in the fields of Mathematics, Chemistry, Physics, and their applications. Hence, my sincere gratitude goes to our four keynote speakers (Prof. Dr. Hadi Nur from University Teknologi Malaysia, Prof. Dr. Hirokazu Saito from Tokyo University of Science, Dr. Devi Putra , ST, M.Sc. from Pertamina Research and Tecnology, and Uyi Sulaeman, Ph.D. from Jenderal Soedirman University), and our six invited speakers (Prof. Dr. Youtoh Imai from Nishogakusha University, Prof. Riyanto, Ph.D. from Universitas Islam Indonesia, Dr. Moh. Adhib Ulil Absor from Gadjah Mada University, Bambang Hendriya Guswanto, Ph.D, Dadan Hermawan, Ph.D. and Dr. Eng. Mukhtar Effendi, M. Eng. from Jenderal Soedirman University) for sharing their expertise in this conference. My deepest appreciation also goes to our 80 presenters and 7 non presenters for their commitment to participate in this conference.

As the output of this conference, some selected papers in the field of chemistry will be published in Jurnal Molekul which is accredited Sinta 1; and other selected papers in the fields of Mathematics, Physics, Physical Chemistry, and Innovative Chemistry Education will be published in IOP Conference Series Journal. So, I greatly thank Jenderal Soedirman University, all our contributors, and all the members of the committee for the invaluable support that makes this conference a reality.
Finally, I would like to apologize for any short comings found in this conference; and hopefully this two-day conference will be engraved in your memory.

The chair of SICoMAS 2019

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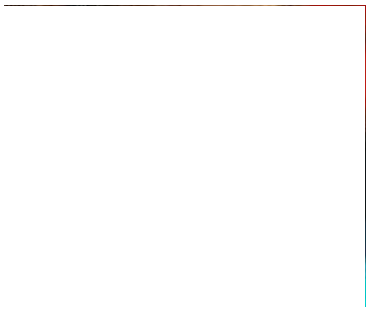

Journal of Physics: Conference Series

COUNTRY

United Kingdom

Universities and research institutions in United Kingdom

SUBJECT AREA AND CATEGORY

Physics and Astronomy
└ Physics and Astronomy (miscellaneous)

PUBLISHER

IOP Publishing Ltd.

H-INDEX

85

PUBLICATION TYPE

Conferences and Proceedings

ISSN

17426588, 17426596

COVERAGE

2005-2021

INFORMATION

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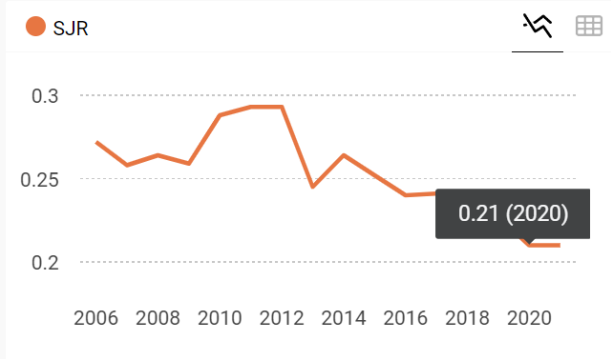
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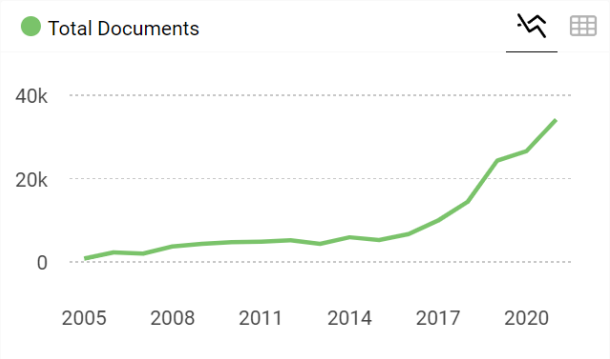
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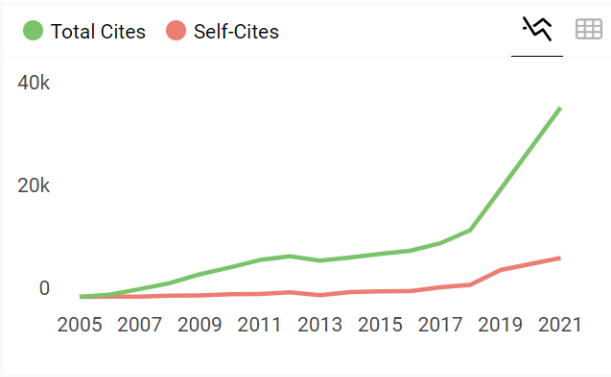
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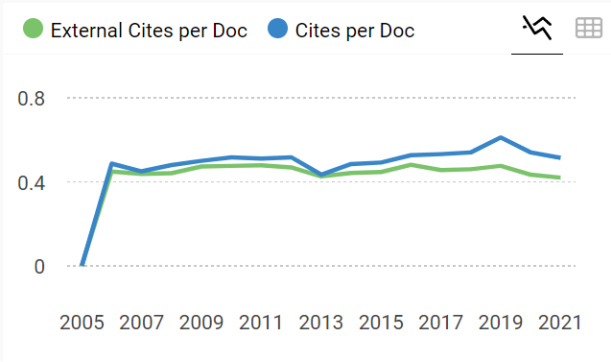
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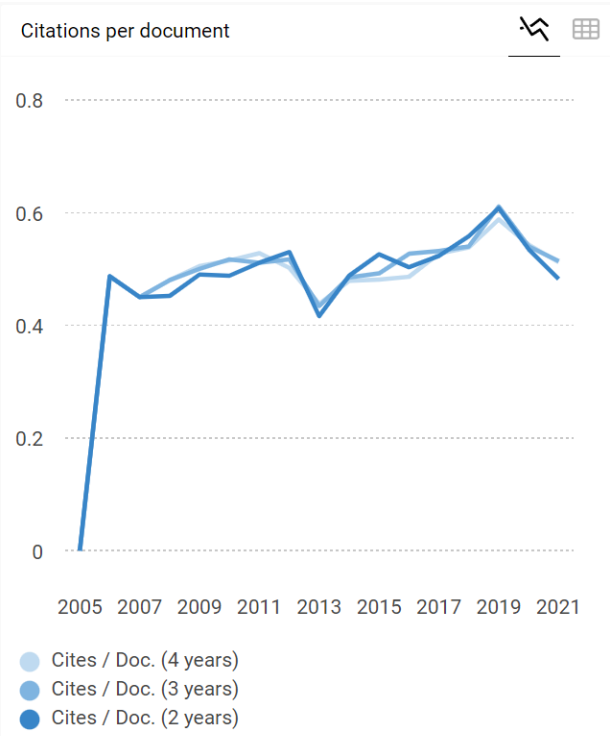
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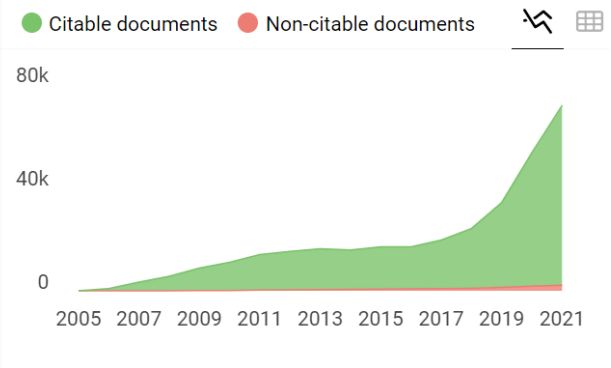

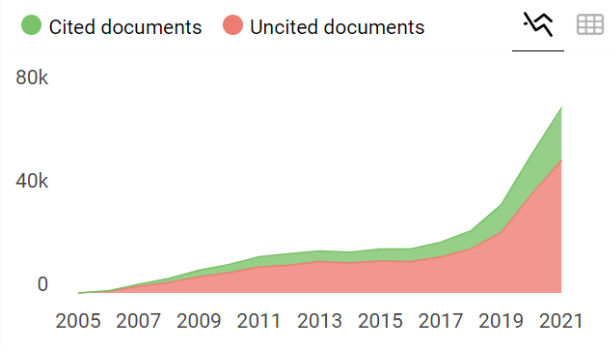

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The pH dependence of Ag_3PO_4 synthesis on visible light photocatalytic activities

The pH dependence of Ag_3PO_4 synthesis on visible light photocatalytic activities

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Abstract. The Ag_3PO_4 morphology modification may affect the photocatalytic activity due to changing the surface energy. It may be designed by coprecipitation under different pH solutions. The pH dependence of Ag_3PO_4 synthesis on photocatalytic reactivities was investigated. The Ag_3PO_4 photocatalysts were synthesized in water-ethanol mixture solution under variation of pH from 3 to 11. The products were characterized using XRD, DRS, SEM, and BET specific surface area. Photocatalytic activities were studied using the degradation of RhB under visible light irradiation. The results showed that the mixed morphologies of the sphere, cube, tetrahedron, and irregular were formed. The highest activity of Ag_3PO_4 was obtained from the synthesis at a pH of 11, which may be caused by a smaller particle size and a higher amount of tetrahedron.

1. Introduction

Recently, Ag_3PO_4 photocatalyst has been widely developed by researchers. Due to low bandgap energy, the Ag_3PO_4 can be utilized for water treatment technology under solar light irradiation. The photocatalytic ability of this catalyst depends on the morphology, size, and composite design. The morphology of Ag_3PO_4 can be controlled by different starting material, concentration, and additive addition. The morphology of the cube was successfully prepared under ammonia [1]. This morphology has higher activity compared to the irregular shape. Other researchers can design the rhombic dodecahedron that improves the catalytic activity [2], higher than that of the cube. It is because the rhombic dodecahedron has higher surface energy. The surface energy of (110) facet in rhombic dodecahedron is higher than that of (100) facet in the cube. The morphology of Ag_3PO_4 can be controlled using the different concentrations of KH_2PO_4 starting material [3]. In this case, the Ag_3PO_4 synthesized with 0.15 M of KH_2PO_4 showed the highest catalytic activity. The mixed morphology of sphere and tetrahedron with a smaller size, defect, and high crystallinity was produced by this method. The addition of additive in the preparation of Ag_3PO_4 enhanced catalytic activity. For instance, the tartaric acid additive can grow the hollow microspheres of Ag_3PO_4 that have high surface areas [4]. This product exhibits high efficient photocatalytic activity under visible light irradiation.

The tremendous development of Ag_3PO_4 is composite design. The composite of Ag_3PO_4/AgI [5], Ag_3PO_4/TiO_2 [6,7], $AgBr/Ag_3PO_4$ [8], $Ag_3PO_4/BiPO_4$ [9], $Ag/Ag_3PO_4/WO_3$ [10] and Ag_3PO_4@g-C_3N_4 core@shell [11] were successfully prepared. Ag_3PO_4/AgI can improve the catalytic reaction through a Z-scheme mechanism composed of AgI, Ag_3PO_4, and Ag. In this system, the metallic Ag nanoparticles acted as the bridge of charge transmission [5]. The heterojunction structures of Ag_3PO_4/TiO_2 can be

designed by wrapping the surface of Ag_3PO_4 with TiO_2 under the sol-gel method [6]. The high catalytic may be caused by the hole-transfer between the valence band (VB) of TiO_2 and Ag_3PO_4. Another heterostructure, Ag_3PO_4 nanoparticle/TiO_2 nanobelt was also successfully synthesized [7]. This heterostructure exhibited higher stability than the Ag_3PO_4 nanoparticles. The excellent properties of AgBr/Ag_3PO_4 composite were prepared using the facile coprecipitation method [8]. This material transformed into Ag/AgBr/Ag_3PO_4 system that improves the stability of photocatalytic reaction. The composite of Ag_3PO_4 quantum dots/$BiPO_4$, which has a p–n junction properties, can be prepared by coprecipitation [9]. The excellent photocatalytic activity of this photocatalyst is mainly caused by a strong visible-light absorption of Ag_3PO_4 quantum dot and high separation of photogenerated electron-hole pairs. The composite of Ag/Ag_3PO_4/WO_3 prepared by a union of deposition-precipitation and photo-reduction method enhanced photocatalytic performance [10]. The high catalytic activity was caused by the synergistic effect of Ag_3PO_4 and WO_3 and the bridge of Ag nanoparticles. The type of core-shell composite of Ag_3PO_4@g-C_3N_4 promoted high strong interaction and high contact of the interface that enhanced the photogenerated charge separation [11].

Up to now, researchers have still developed the method of improvement in this catalyst. The pH of the solution in coprecipitation might affect the morphology. It is very challenging because the pH treatment is an easy process of synthesis. A facile sonochemical method was used to synthesize Ag_3PO_4 particles at a pH of 3,7,11 [12]. The samples prepared at pH of 7 and 11 exhibited similar morphology and size with the average particle size of ~300 nm. In contrast, the sample prepared at a pH of 3 is composed of polyhedral micro-particles with a larger size of 5–8 μm. Inspired by this finding, it is very challenging to synthesize the Ag_3PO_4 at different pH using the coprecipitation method. The coprecipitation method is the low-cost method due to no energy utilized in the preparation. This paper presented the pH dependence of Ag_3PO_4 synthesis under the coprecipitation method. The pH solution significantly affects the properties of Ag_3PO_4. The highest catalytic activity was obtained at a pH of 11.

2. Materials and Methods

2.1. Material Preparation

The starting material of $AgNO_3$ with 3.36 g was dissolved in 25 mL of a water-ethanol mixture (1: 1). The pH variation was setting on the ethanol-water mix with the addition of 0.1 M HNO_3 to obtain the solution of pH 3 and 5 and using 0.1 M NaOH to adjust the pH of 9 and 11. The solution of phosphate ion was created using 1 g of H_3PO_4 dissolved in 25 mL of ethanol. The phosphate solution was slowly added to the solution of $AgNO_3$ in water-ethanol under stirring for 30 minutes. The precipitate was separated and washed with deionized water three. The precipitates were dried in an oven at 105^{o}C for 7 hours.

2.2. Material Characterization

The Ag_3PO_4 structures were investigated using by X-ray Diffractometer (XRD) (Cu Kα, λ=1.5406 Å. The shape of the crystal was studied using the Scanning Electron Microscopy (SEM). The absorption and bandgap energy were determined using the Diffuse Reflectance Spectroscopy (DRS). Surface area samples were determined using the BET method.

2.3. Photocatalytic Activity

Photocatalytic activities were evaluated through the degradation of Rhodamine B (RhB) [3]. The RhB solutions with 10 mg/L and 100 mL of volume were introduced into a beaker glass and stirred. The blue light of the LED lamp was put at 10 cm above the surface of the RhB solution. The reaction was carried out in the dark for 30 minutes and continue with the reaction in the light. Every 10 minutes, 5 ml of the samples were centrifuged (1500 rpm, 60 minutes), and then the absorbance of RhB was measured by UV-Vis. The photocatalyst stability was evaluated under three cycles of the catalytic reaction.

3. Results and Discussion

The body-centered cubic structures (JCPDS No. 06-0505) were identified in all of Ag_3PO_4 synthesized under different pH solutions (figure 1), indicating that the variation of pH solution did not affect the structure of Ag_3PO_4. The impurities were not observed in the samples, suggesting that the samples were in a high purity crystalline.

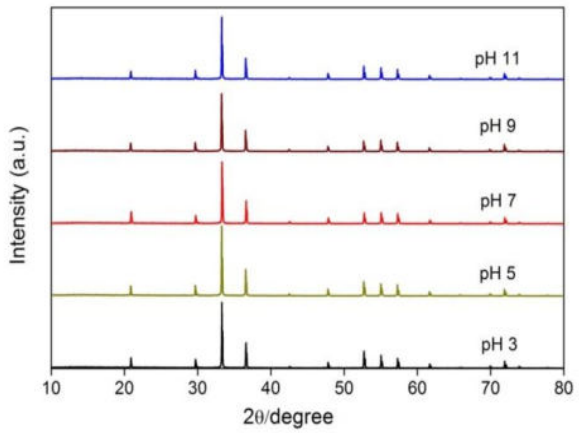

Figure 1. X-ray diffraction of Ag_3PO_4 synthesized under water-ethanol solution in the different pH solutions.

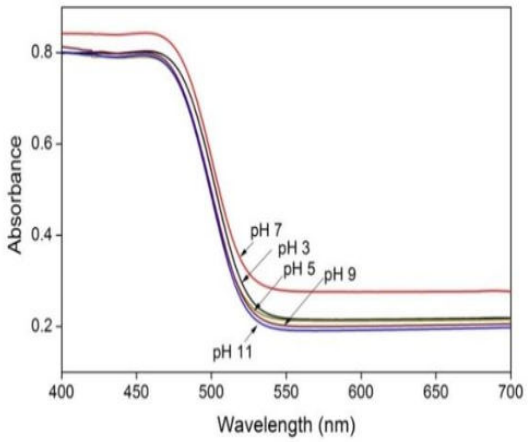

Figure 2. DRS of Ag_3PO_4 synthesized under water-ethanol solution at different pH solutions.

Figure 2 showed the absorption of Ag_3PO_4 synthesized at different pH solutions. There is a difference absorption edge among the samples, the sample prepared at pH of 7 showed higher absorption in the visible region of wavelength. It indicates that the different pH solution affects the absorption and bandgap energy. The bandgap energies of the samples are shown in table 1.

Table 1. Bandgap energies and rate constants of Ag_3PO_4 synthesized in a variety of pH.

pH solution of synthesis	Bandgap energy (eV)	*Rate constant* (min^{-1})
3	2.29	0.0365
5	2.30	0.0385
7	2.27	0.0383
9	2.29	0.1051
11	2.31	0.1176

Figure 3 showed the morphology of Ag_3PO_4 prepared at a pH of 3, 7, and 11. The morphologies of sphere, cubes, tetrahedron, and irregular were formed. The sample prepared at pH of 3 was dominated by irregular, whereas the cubes and the tetrahedron were not perfectly created. With increasing the pH solution, the tetrahedron concentration increases. The higher amounts of the tetrahedron with the smaller particle size are found at a pH of 11. Based on these results, the morphology of Ag_3PO_4 is significantly affected by pH solution of synthesis. The acid solution might not suppress the agglomeration and producing a large particle, whereas the basic solution might prevent the agglomeration and producing

small particles. This phenomenon is very important for the photocatalytic reaction, which is influenced by particle size and morphology. However, both acid and basic solution has produced ununiform in particle size distribution.

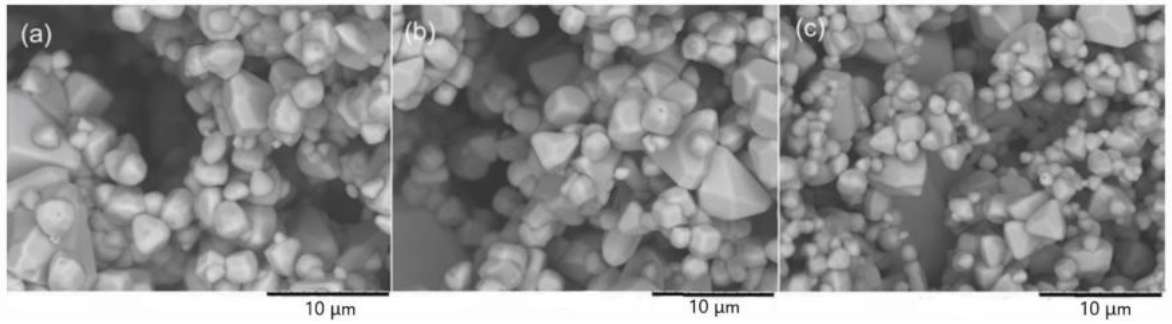

Figure 3. SEM images of Ag_3PO_4 photocatalyst synthesized at pH of 3 (a), 7 (b), and 11 (c).

Table 2. Particle size and specific surface area (S.S.A) of Ag_3PO_4 synthesized under different pH solution

pH solution of synthesis	Particle size (µm)	S.S.A (m^2/g)
3	2.5 – 5.0	6.18
7	1.5 – 4.5	6.56
11	1.0 – 3.5	7.00

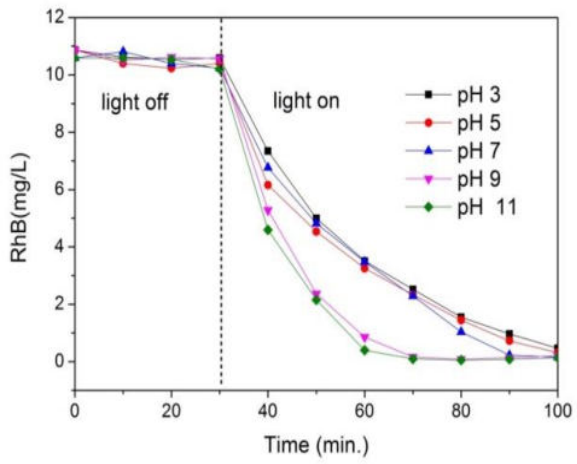

Figure 4. The photocatalytic activity of Ag_3PO_4 synthesized under the water-ethanol solution in different pH solutions.

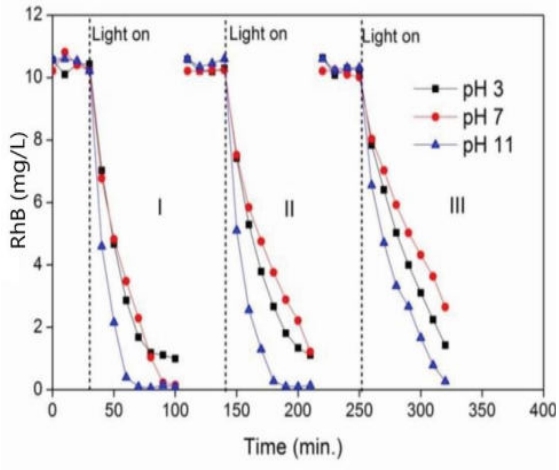

Figure 5. Cycling runs in the photodegradation of RhB using the Ag_3PO_4 photocatalyst prepared at a pH of 3, 7, and 11.

Figure 4 showed the photocatalytic activity of Ag_3PO_4 synthesized under the water-ethanol mixture in different pH solutions. After the blue light turns on, the concentration of RhB decreases significantly,

indicating that all of the samples have photocatalytic activity. The samples prepared at pH of 9 and 11 exhibit higher catalytic activity compared to a pH of 3, 5, and 7, suggesting that the higher pH solution can improve the photocatalytic ability. This higher activity may be caused by smaller particle size and higher tetrahedron content, as shown in Fig.3(c). The smaller particle size of Ag_3PO_4 can increase the surface area (table 2), which leads to improving catalytic activity.

Figure 5 showed the photocatalytic reaction up to 3 cycles. At cycle II, the photocatalytic activity of the sample prepared at pH of 11 showed a similar ability with the cycle I, indicating that this sample has high stability. However, at cyclic III, the catalytic activity decreases. It might be caused by little loss of the catalyst when collecting the sample after the photocatalytic reaction. The photocatalytic activities of the sample prepared at a pH of 3 and 7 decreases at cycle II, implying that these samples have low stability.

4. Conclusion

The photocatalysts of Ag_3PO_4 were successfully synthesized under the water-ethanol mixture solution with the variation of pH. The results showed that the mixed morphology of sphere, cube, tetrahedron, and irregular was formed. The highest activity and stability of Ag_3PO_4 were obtained under the preparation at a pH of 11, which may be caused by smaller particle size and higher tetrahedron content.

Acknowledgments

This research was partly supported by the Ministry of Education and Culture of the Republic of Indonesia in the Scheme of Basic Research, 176/SP2H/LT/DRPM/2019.

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