

Effects of adding TEOS for  
Upr/core Shell  
Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub>composites  
nanoparticle from iron sand as  
microwave absorption materials  
*by Harini Sosiati*

---

**Submission date:** 24-Jun-2020 01:29PM (UTC+0700)

**Submission ID:** 1348931169

**File name:** 11\_Effect\_of\_Adding\_Teos.pdf (1.61M)

**Word count:** 2772

**Character count:** 14704

# Effects of adding TEOS for Upr/core-Shell $\text{Fe}_3\text{O}_4@\text{SiO}_2$ composites nanoparticle from iron sand as microwave absorption materials

<sup>1</sup> Cite as: AIP Conference Proceedings 2097, 030116 (2019); <https://doi.org/10.1063/1.5098291>  
Published Online: 23 April 2019

Yusmaniar, Maulidya, Wisnu Ari, Harini Sosiati, and Erfan Handoko



View Online



Export Citation

## <sup>1</sup> ARTICLES YOU MAY BE INTERESTED IN

<sup>1</sup> About measuring the forbidden 1S-2S transition frequency of a hydrogen atom by stimulated Raman scattering

AIP Conference Proceedings 2098, 020001 (2019); <https://doi.org/10.1063/1.5098145>

Slow pyrolysis of Tectona Grandis and Albizia Chinensis sawdust with thermogravimetry analysis

<sup>1</sup> AIP Conference Proceedings 2097, 030080 (2019); <https://doi.org/10.1063/1.5098255>

<sup>2</sup> Evaluation for detecting and monitoring of offshore pipeline damage based on risk based inspection method

<sup>6</sup> AIP Conference Proceedings 2097, 030086 (2019); <https://doi.org/10.1063/1.5098261>

AIP | Conference Proceedings

Get **30% off** all  
print proceedings!

Enter Promotion Code **PDF30** at checkout



# Effects of Adding Teos For Upr/Core-Shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> Composites Nanoparticle from Iron Sand as Microwave Absorption Materials

Yusmaniar<sup>1a</sup>, Maulidya<sup>2b</sup>, Wisnu Ari<sup>3c</sup>, Harini Sosiati<sup>4d</sup> and Erfan Handoko<sup>5</sup>

<sup>1,2</sup> Departement of Chemistry, Faculty of Match and Science Universitas Negeri Jakarta, Kampus A Rawamangun Muka Jakarta Timur 13220, Indonesia

<sup>3</sup> Centre for Science and Technology of Advanced Materials, National Nuclear Energy Agency, Kawasan Puspittek Serpong, Tangerang Selatan, Banten, Indonesia

<sup>4</sup> Department of Mechanical Engineering, Faculty of Engineering Universitas Muhammadiyah Yogyakarta, Tamantirto, Kasihan Bantul Yogyakarta

<sup>5</sup> Dept of Physics, Universitas Negeri Jakarta, Jalan Rawamangun Muka 13220, Jakarta Indonesia

<sup>a</sup>corresponding author: [yusmaniar@unj.ac.id](mailto:yusmaniar@unj.ac.id)

<sup>b</sup>[molidya3@gmail.com](mailto:molidya3@gmail.com)

<sup>c</sup>[dwisnuuaa@batan7.id](mailto:dwisnuuaa@batan7.id)

<sup>d</sup>[hsosieti@ft.umy.ac.id](mailto:hsosieti@ft.umy.ac.id)

**Abstract.** This study aims for synthesized UPR/Core-Shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composites as microwave absorption materials. In this research nanoparticle, Fe<sub>3</sub>O<sub>4</sub> was synthesized by using coprecipitation methods from the iron sand with NaOH solution. Core-Shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> was synthesized by using Stober methods by using Tetraethylorthosilicate (TEOS) as precursor substances, where nanoparticle Fe<sub>3</sub>O<sub>4</sub> as core and SiO<sub>2</sub> the shell. The addition of TEOS was adding in the variation of volume and SEM study indicated that with an increase in TEOS content the particle of core-shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> become bigger. Composites were synthesized with core-shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> as the filler and UPR as the matrix. Then, composites were tested for electromagnetic microwave absorption using VNA (Vector Network Analyzer) at 8–12 GHz frequency. The result proved that UPR/Core-Shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composites were able to absorb electromagnetic waves at 9 GHz frequency with absorption large range up to -15,8 dB.

## INTRODUCTION

Electromagnetic energy can be generated from the excessive use of electronic devices and can cause microwave radiation. Microwave radiation is included in Electromagnetic Interference (EMI) problem that can occur in gadgets if there's any leakage of wave energy [1]. Therefore, a material that can reduce reflections and absorbent microwaves is needed. Microwave absorbent material can reduce reflections and absorb microwave radiation through conversion into heat energy [2 - 5]. The ideal microwave absorbent material must have an electrical permittivity and magnetic permeability. The properties of magnetic permeability, one of is owned by Fe<sub>3</sub>O<sub>4</sub> or iron (II), (III) oxide because of its unique magnetic characteristics[6 - 8]. Meanwhile, silica as having an active group such as silanol (-Si-OH) and siloxane (Si-O-Si) has an electric permittivity property that can enhance the absorption ability of microwaves.

Fe<sub>3</sub>O<sub>4</sub> nanoparticles are obtained from natural materials, namely iron sand. Iron sand is widely used as the main ingredient in producing magnetite. Magnetite can be extracted from iron sand using the coprecipitation method. Meanwhile, silica is synthesized from Tetraethylorthosilicate precursors (TEOS). Fe<sub>3</sub>O<sub>4</sub> nanoparticle material and silica modified into a single material namely core-shell, with Fe<sub>3</sub>O<sub>4</sub> nanoparticles as the core (core) will be coated by silica (shell) on the entire surface. This modification is performed to solve some problems of Fe<sub>3</sub>O<sub>4</sub> nanoparticles as easily agglomerated because of the large surface area, high surface energy and paramagnetic properties [9].

Fabrication of microwave absorbent material in the form of UPR-based composite filled with core-shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub>. The core-shell composition will be made in several comparisons between Fe<sub>3</sub>O<sub>4</sub> and TEOS. The making of composite materials is needed as a polymer matrix. The matrix is a constituent with the largest volume that functions as a binder. The matrix used in this study is Unsaturated Polyester Resin (UPR). UPR is a polymer

that has good mechanical and dielectric properties compared to others polymers so it is very good as a support to produce optimal composites [10].

The UPR composite / core-shell  $\text{Fe}_3\text{O}_4@/\text{SiO}_2$  will be measured for its absorption ability on microwaves using VNA (Vector Network Analyzer). This material will be analyzed in the frequency of X Band type electromagnetic waves (band X) in the range of 8 - 12 GHz. This frequency is used in RADAR, communication and electronic technology applications.

## EXPERIMENTAL

Tetraethylorthosilicate (TEOS), HCl, NaOH, Trisodium Citrate, Ethanol, 25%  $\text{NH}_4\text{OH}$ , demineralized water (aqua DM) and Unsaturated Polyester Resin (UPR) polymers. Particle Size Analyzer (PSA) to determine the size distribution of owned by  $\text{Fe}_3\text{O}_4$  and Core-shell  $\text{Fe}_3\text{O}_4@/\text{SiO}_2$  nanoparticles, Fourier Transform Infrared Spectroscopy (FTIR) to determine the functional groups in UPR / Core-shell  $\text{Fe}_3\text{O}_4@/\text{SiO}_2$  composites, X-Ray Diffraction (XRD) to identify crystalline phases of Core-shell  $\text{Fe}_3\text{O}_4@/\text{SiO}_2$ , Scanning Electron Microscopy (SEM) to determine the morphology of Core-shell  $\text{Fe}_3\text{O}_4@/\text{SiO}_2$  and Vector Network Analyzer (VNA) to measure composites against microwave absorption strength.

Magnetite ( $\text{Fe}_3\text{O}_4$ ) is extracted from iron sand by dissolving in 6M HCl and stirred with a magnetic stirrer for 30 minutes. After that, the precipitating agent NaOH is slowly added. The resulting reaction results are then washed repeatedly with aqua DM until neutral and free of impurities. Permanent magnets are placed in the bottom of the glass with the aim of being able to pull  $\text{Fe}_3\text{O}_4$  so that it precipitates faster than  $\text{Fe}_2\text{O}_3$ . A synthesis of  $\text{Fe}_3\text{O}_4$  nanoparticles is ball-milling for 20 hours.

$\text{Fe}_3\text{O}_4$  nanoparticles that have been made are modified with silica from TEOS to be made into core-shell to increase the absorption capability of  $\text{Fe}_3\text{O}_4$ . First,  $\text{Fe}_3\text{O}_4$  nanoparticles will be produced by coprecipitation method. Second, the silica coating process on the surface of  $\text{Fe}_3\text{O}_4$  forms a core-shell with the stÖber method or hydrolysis of TEOS. Synthesis of core-shell  $\text{Fe}_3\text{O}_4$  nanoparticles begins by dissolving  $\text{Fe}_3\text{O}_4$  nanoparticles in trisodium citrate 0.3 M and ultrasound for 1 hour. The results of  $\text{Fe}_3\text{O}_4$  nanoparticle deposits were dissolved in ethanol and water in a ratio of 4: 1 and then ultrasonic for 1 hour. The solution was then added with 25%  $\text{NH}_4\text{OH}$  and tetraethylorthosilicate (TEOS) slowly in a distorted state. The addition of TEOS is done in several variations, namely 2 ml; 2.5 ml and 3 ml. Then the solution is maintained in a stirrer condition for  $\pm 24$  hours and repeated washing is done using water and ethanol to neutral.

## RESULTS AND DISCUSSION

### Synthesis $\text{Fe}_3\text{O}_4$ Nanoparticles

$\text{Fe}_3\text{O}_4$  nanoparticles were successfully synthesized through coprecipitation method and ball-milling. Figure 1 shows the size distribution the  $\text{Fe}_3\text{O}_4$  Nanoparticles located at 48.66 nm with the value of Polydispersity Index (PDI) of 0.598. This shows that magnetite is already on a nanometer scale with high homogeneity [6].

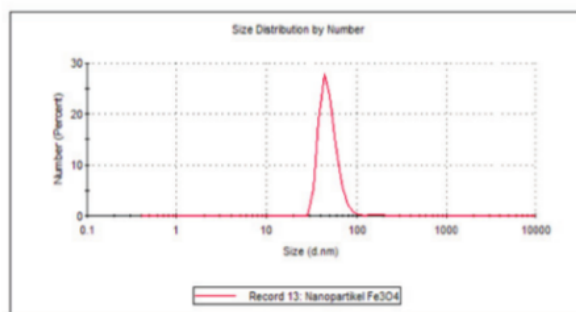


FIGURE 1. Size distribution of  $\text{Fe}_3\text{O}_4$  Nanoparticles

The IR spectrum of the  $\text{Fe}_3\text{O}_4$  nanoparticle is shown in Fig 2. The IR spectrum of  $\text{Fe}_3\text{O}_4$  nanoparticles showed a strong typical peak at wave numbers  $582.50 \text{ cm}^{-1}$  which were suspected of stretching Fe-O bonds. Whereas, at wave number  $3388.93 \text{ cm}^{-1}$  there is a widening typical peak which is thought to be the vibration of water ( $\text{H}_2\text{O}$ ) in the sample. The results of the  $\text{Fe}_3\text{O}_4$  nanoparticle pattern XRD are shown in Figure 3. The suitability of the diffraction pattern shows the crystallinity of magnetite compound. The suitability of the data results with the database is indicated by the magnetite database source number 99-101-2444. The highest peak was at 2 thetas  $35.32$  in the area of 311, followed by peaks at 2 thetas  $62.75$  in the field of 440;  $30.00$  in the field of 220 fields;  $57.00$  in the field of 511;  $43.06$  in the fields of 400 and  $18.25$  in the 111 field.

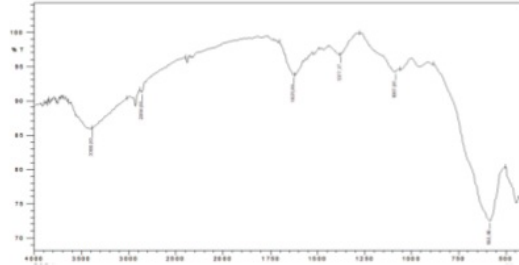


FIGURE 2. IR Spectrum of  $\text{Fe}_3\text{O}_4$  Nanoparticles

The XRD pattern is processing with the Highscore software obtained crystallinity measurements of  $\text{Fe}_3\text{O}_4$  nanoparticles, namely  $232.2 \text{ \AA}$  or  $23.2 \text{ nm}$ . This shows that the crystal size of  $\text{Fe}_3\text{O}_4$  nanoparticles is on the nanoscale and this data is in accordance with Particle Size Analyzer (PSA) measurements using Dynamic Light Scattering (DLS) analysis techniques.

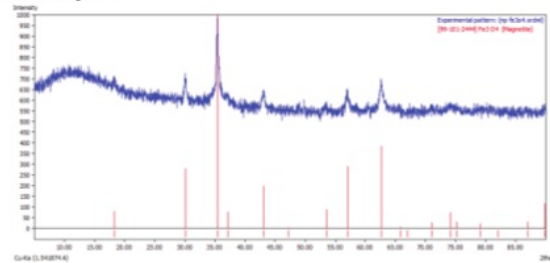


FIGURE 3. XRD Pattern of  $\text{Fe}_3\text{O}_4$  nanoparticles

Figure 4 shows the particle shape of  $\text{Fe}_3\text{O}_4$  is round and quite uniform. However, there was a high agglomeration so that the morphology on the surface of  $\text{Fe}_3\text{O}_4$  nanoparticles was not smooth enough. Aggregation can reduce the surface energy that occurs in  $\text{Fe}_3\text{O}_4$  nanoparticles, this can occur because a materials nanoparticle has very high surface energy [7]. Then, the measurement (scaler) in the image is done on several spot particles that are round in shape with an average diameter of  $37 \text{ nm}$ .

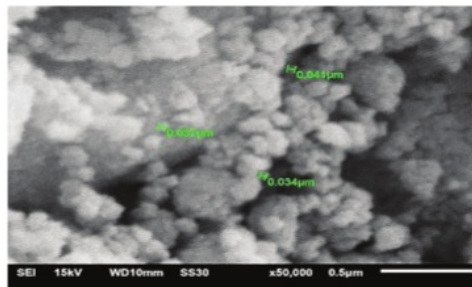


FIGURE 4. SEM morphology of  $\text{Fe}_3\text{O}_4$  Nanoparticles

## Synthesis Core-shell $\text{Fe}_3\text{O}_4@\text{SiO}_2$

Based on Figure 5, there are absorption peaks in wave numbers 3247.62  $\text{cm}^{-1}$ , 1089.78  $\text{cm}^{-1}$  and 580.57  $\text{cm}^{-1}$  indicating the vibration between elements of O-H, Si-O and Fe-O [8]. The wide absorption peak at wave number 3207.62  $\text{cm}^{-1}$  is the O-H strain and bending vibration of H-O-H and adsorption by water. The characteristics of the three absorption peaks in the wave number indicate the characteristic between magnetite and silica so that it can be said that the core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  has been formed.

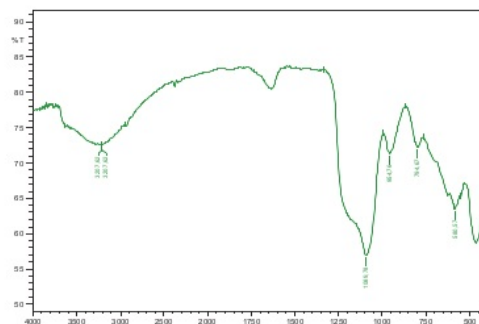


FIGURE 5. IR Spectrum of  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  Nanoparticles

The synthesized core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  is then tested with an XRD device to determine the phase formed. In Figure 6 is a diffraction pattern of core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  with a ratio of silica thickness. Tests were carried out on 2 thetas  $20^\circ$ - $80^\circ$  and all three core-shell samples  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  produced six characteristic magnetite peaks ( $\text{Fe}_3\text{O}_4$ ) [9].

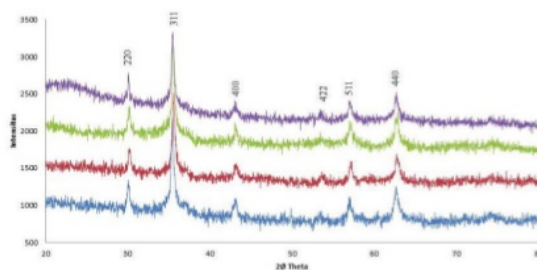


FIGURE 6. XRD diffraction pattern (a) NPs  $\text{Fe}_3\text{O}_4$ , (b) core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  with TEOS (2 ml), (c) 2.5 ml and (d) 3 ml

Figure 6 shows that the three core-shell samples  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  do not change the characteristic peak position of  $\text{Fe}_3\text{O}_4$  nanoparticles. There is also a widening peak at 2 thetas  $20^\circ$  -  $30^\circ$  which indicates the presence of ( $\text{SiO}_2$ ) silica with an amorphous phase. In the diffraction pattern (c) it can be seen that the silica formed is quite high compared to diffraction patterns (a) and (b). It can be concluded that the procedure of coating or modification of core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  does not change the crystalline structure of  $\text{Fe}_3\text{O}_4$  nanoparticles.

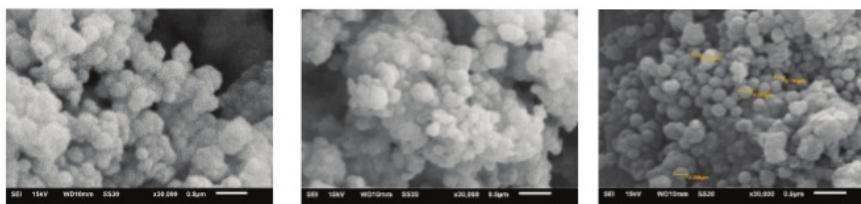
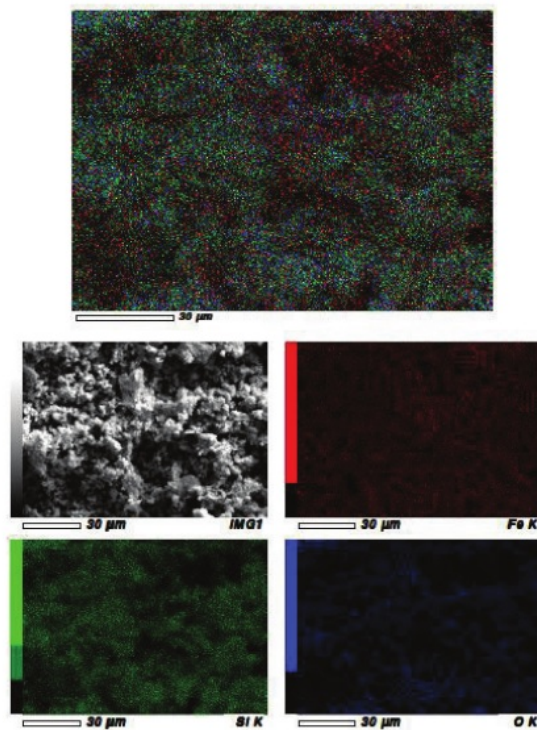


FIGURE 7. SEM morphology of core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$

In Figure 7 (a) is a core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  by TEOS addition of 2 ml, round-shaped surface morphology. The characteristics of spherical particle shape are characteristic of magnetite ( $\text{Fe}_3\text{O}_4$ ) [10]. High agglomeration is possible because the silica coating is not enough to prevent reactivity of  $\text{Fe}_3\text{O}_4$  nanoparticles. Meanwhile, in Figure 7 (b) the core-shell surface is  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  with the addition of TEOS 2.5 ml round shape which is quite uniform and smooth. The average core-shell  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  particle size is 150 nm. Also, in Figure 7 (c), the core-shell surface of  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  round particles is larger but the surface is not smooth enough compared to figure 7 (b).

Analysis with SEM continued with mapping in Figure 8 which was carried out at 3000 times magnification. In Figure 8 (a) there are several elemental signals consisting of elements of Fe, Si, and O. The appearance of the Fe signal in figure 8 (c) is seen to be distributed throughout the sample with a low intensity of red contrast. Then, the signal element with green contrast is the Si element shown in figure 8 (d) also distributed thoroughly on the surface of Fe. The intensity of the Si element signal is higher than Fe due to the position of silica as a shell or located on the surface of Fe (core). In Figure 8 (e) is a signal display representing the O element that is seen as a whole O element distribution. This is because the element of oxygen (O) also binds to elements of Fe and Si. Based on the analysis of testing and mapping of SEM on  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  core-shell it can be concluded that silica successfully coated the entire surface of  $\text{Fe}_3\text{O}_4$  nanoparticles.



3  
FIGURE 8. SEM Mapping of *core-shell*  $\text{Fe}_3\text{O}_4@\text{SiO}_2$

The synthesized *core-shell*  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  is then used as filler in a composite with UPR (Unsaturated Polyester Resin) matrix with a weight/ weight ratio (w / w%) between UPR and *core-shell* is 85%: 15% of the total mass of the composite 2 grams.

FTIR spectrum of composites can be seen in Figure 9, showing typical absorption peaks of functional groups found in UPR compounds. Typical absorption peaks in benzene, polyester, and esters are each wave numbered  $744.52\text{ cm}^{-1}$ ,  $1128.36\text{ cm}^{-1}$ , and  $1278.81\text{ cm}^{-1}$ . Strain C-H bonds are also found in wave numbers  $1728.22\text{ cm}^{-1}$  and  $2926.01\text{ cm}^{-1}$ . At wave numbers  $3400.50\text{ cm}^{-1}$  there is a widened absorption peak which shows the vibration

characteristics of O-H bonds from Si-OH and H<sub>2</sub>O in magnetite compounds. Whereas, at wave numbers 1070.49 cm<sup>-1</sup> and 518.85 cm<sup>-1</sup> there is a typical absorption peak that shows the strain characteristics of Si-O and Fe-O. This result can prove the synthesis of UPR / core-shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composites has been successfully made

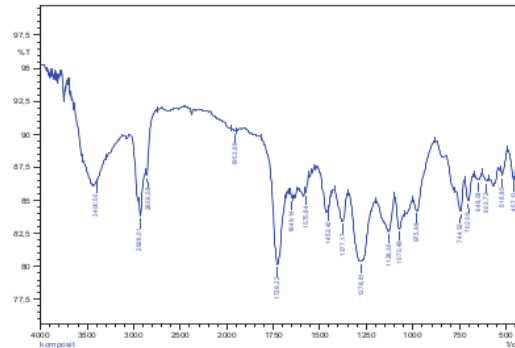


FIGURE 9. IR spectrum of UPR/*Core-shell* Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composites

The optimum composition of the material for the absorption of electromagnetic waves is the addition of silica or as a magnetite coating in the core-shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> of 3 ml. The optimum absorption of UPR/core shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composite to microwaves at 9 GHz wave frequency is -15.8 dB. The test results of core-shell composite material Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> for microwave absorption can be seen in Figure 10.

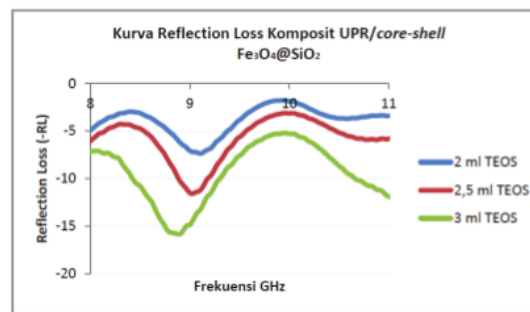


FIGURE 10. Reflection Loss from UPR/*core-shell* Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composites

## CONCLUSIONS

Based on the discussion of the results of the UPR / core-shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> composite research on microwave absorption capability, the following conclusions can be drawn:

1. Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> nanoparticle core-shell material was successfully synthesized
2. The composition of silica in the UPR / core-shell composite Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> which has the maximum absorption is the addition of TEOS 3ml
3. The maximum absorption of microwaves occurs at a frequency of 9 GHz with the greatest absorption capability of -15.8 dB.



## REFERENCES

- [1]. Singh, Samarjit, Ankur Sinha, Raj Hemant, Abhishek Kumar, and Dharmendra Singh, 29: 2019-2026 (2018).
- [2]. Erfan Handoko et al 2018 *Mater. Res. Express* 5 (2018) 064003 <https://doi.org/10.1088/2053-1591/aac4d7>
- [3]. E. Handoko et al 2018 *J. Phys.: Conf. Ser.* **1080** 012023 doi :10.1088/1742-6596/1080/1/012023.
- [4]. E. Handoko et al 2018 *J. Phys.: Conf. Ser.* **1080** 012002 doi :10.1088/1742-6596/1080/1/012002.
- [5]. Zhang, Kaichuang et al, 748: 706-716 (2018).
- [6]. Erfan Handoko, et al, “Microwave Absorbing Studies of Magnetic Materials for X-Band Frequencies,” vol. 19, pp. 17–20, 2017. <https://doi.org/10.1109/BCWSP.2017.8272575>.
- [7]. Erfan Handoko, et. al, “Measurement of Complex Permittivity and Permeability of Hexagonal Ferrite Composite Material Using a Waveguide in Microwave Band,” 2016 International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications Measurement pp. 28–30, 2016. <https://doi.org/10.1109/ICRAMET.2016.7849576>.
- [8]. Wang, Yanping, Danping Sun, Gongzong Liu, and Wei Jiang, 26: 1537-1543 (2015).
- [9]. Alexandrescu, Laura and Anton Ficai, 21: 5324-5335 (2015).
- [10]. Dholakiya, Bharat, *Unsaturated Polyester Resin for Specialty Applications. Review. India : Intech*, 04062012 (2011).
- [11]. Lim, Jitka, Swee Pin Yeap, Hui Xin Che, and Siew Chun Low, 8:1-14 (2013).
- [12]. Liu, Jian, Shi Zhang Qiao, Qiu Hong Hu, Gao Qing, and Max Lu, 7: 425-443 (2011).
- [13]. Rubio, F., J. Rubio, and J. L. Oteo, 31: 199-219 (1998).
- [14]. Hui, Chao et al, 3: 701-705 (2011).
- [15]. Ding, H. L. et al, 24:4572–4580 (2012).

# Effects of adding TEOS for Upr/core Shell Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub>composites nanoparticle from iron sand as microwave absorption materials

## ORIGINALITY REPORT

11%	%	11%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

## PRIMARY SOURCES

- 1 S. I. Gusev, V. Yu. Soboleva, I. L. Kublanova, M. K. Khodzitsky. "Glucose level sensor based on metasurface in THz frequency range", AIP Publishing, 2019 2%

Publication
- 2 Prima Febriyana, Gunawan Dwi Haryadi, Achmad Widodo, Mohammad Tauviqirrahman et al. "Evaluation for detecting and monitoring of offshore pipeline damage based on risk based inspection method", AIP Publishing, 2019 2%

Publication
- 3 Qi Xiao. "Preparation and Characterization of Silica-Coated Magnetic-Fluorescent Bifunctional Microspheres", Nanoscale Research Letters, 06/20/2009 1%

Publication
- 4 Y Yusmaniar, W Ari A, D K Hutomo, E Handoko. " Electromagnetic wave absorbing properties of husk silica-based SiO<sub>2</sub>/Fe<sub>3</sub>O<sub>4</sub>/UPR composite ", 1%

5

Erfan Handoko, Anggoro B S, Iwan Sugihartono, Mangasi AM, Dini Siti Nurwulan, Serafin Christina, Zulkarnain Jalil. "Structure and magnetic properties of Co-Zn substituted hexagonal ferrites", MATEC Web of Conferences, 2018

Publication

---

1%

6

Alexey Chibrarov, Mikhail Efimov, Ilya Romanchenko, Artem Berezutsky et al. "Investigation and analysis of the characteristics of the laser plasma expansion by the spectroscopic methods, magnetic and optical diagnostics", AIP Publishing, 2019

Publication

---

1%

7

Yusmaniar, Arie Restu, Nurhidayani, Fera Kurniadewi. "Synthesis of tannin phenol formaldehyde (Tpf) copolymer from ethyl acetate extract of green tea leaf (Camellia Sinensis) as bioadhesive wood", AIP Publishing, 2019

Publication

---

1%

8

Indrani, Decky Jusiana, Bambang Sunendar Purwasasmita, Wisnu Ari Adi, and Jojo Simanjuntak. "Preparation and Characterization

1%

of Magnetic Carbonate  
Apatite/Chitosan/Alginate Composite Scaffold",  
Materials Science Forum, 2015.

Publication

---

9

An-Hui Lu, E. L. Salabas, Ferdi Schüth.  
"Magnetic Nanoparticles: Synthesis, Protection,  
Functionalization, and Application", Angewandte  
Chemie International Edition, 2007

1%

Publication

---

10

Asghar Faghihi, M.H. Vakili, Ghader  
Hosseinzadeh, Mousa Farhadian, Ziaeddin  
Jafari. "Synthesis and application of recyclable  
magnetic freeze-dried graphene oxide  
nanocomposite as a high capacity adsorbent for  
cationic dye adsorption", Desalination and  
Water Treatment, 2016

1%

Publication

---

Exclude quotes

On

Exclude matches

< 1%

Exclude bibliography

Off