Magnetic Properties of Silicon Dioxide (SiO$_2$) from Reed Biomass

N P Har$^{1,a}$, D A P Wardani$^{2,b}$, B Hariyanto$^{3,c}$, N Kurniawati$^{3,d}$, N Darmawan$^{4,e}$ and Irzaman$^{1,f}$

$^1$Physics Department, FMIPA, IPB University
IPB Dramaga Bogor, West Java, Indonesia, 16680
$^2$Chemistry Program, FMIPA, Palangka Raya University
Palangka Raya, Central Kalimantan, Indonesia, 73111
$^3$Physics Program, FMIPA, Palangka Raya University
Palangka Raya, Central Kalimantan, Indonesia, 73111
$^4$Chemistry Department, FMIPA, IPB University
IPB Dramaga Bogor, West Java, Indonesia, 16680

Email: $^{1,a}$nazopatul_biofis@apps.ipb.ac.id

Abstract. Silicon dioxide (SiO$_2$) from reed biomass has successfully synthesized by annealing temperature variation at 500 oC, 600 oC, and 700 oC. The electrical properties of silicon dioxide from reed biomass have been analyzed by LCR-meter. The data collection point of each sample was 200 points. The frequency range of each sample was collected at 50 Hz to 5 MHz, alternating current voltage at 1 V, and alternating current at 50 mA. Then, the magnetic properties have calculated in Vicinity Magnetic Induction (VMI) and magnetic flux. The VMI value result of each sample has calculated at the order of 10$^{-7}$ – 10$^{-6}$ tesla and magnetic flux value at the order of 102 - 104 weber. Application of magnetic properties in the form of Vicinity Magnetic Induction (VMI) and magnetic flux of silicon dioxide from reed biomass was the forerunner as a magnetic sensor.

1. Introduction
Reed (Imperata cylindrica) is one of the natural vegetation that is very abundant in the tropics and subtropics. The potential development of silicon dioxide (SiO$_2$) from reed (Imperata cylindrica) is very interesting to study. The potential development of silicon dioxide (SiO$_2$) is based on the widespread use of SiO$_2$-based materials in industry. Silicon dioxide is widely used for various purposes with various sizes depending on the application needed, such as in the tire, rubber, glass, cement, concrete, ceramic, textile, paper, cosmetic, electronics, paint, film, toothpaste and adsorbent industries [1,2]. In addition to processed form, silicon dioxide is also widely used directly for refining vegetable oil, as an additive in pharmaceutical products and detergents [3].

Besides reeds biomass, silicon dioxide can also be extracted from rice straw biomass[4] bamboo leaves [5,6], rice husks [7-9], bagasse [10] and coconut husks [11].

This study aims to study and analyze the ignition temperatures on the silicon dioxide content of reeds and measure its magnetic properties including of Vicinity Magnetic Induction (VMI) and magnetic flux in the frequency range at 50 Hz to 5 MHz.
2. Methods
Silicon dioxide from reed biomass was extracted in several steps including: (i) alang-alang leaves 1 g soaked in 12 ml of 3% technical HCl at 200°C for 3 hours (ii) reed samples rinsed with aquabides until neutral. (pH = 7), (iii) reed samples were dried and burned in an open space, (iv) reed charcoal is burned in a furnace 500°C, 600°C, 700°C, (v) extraction of SiO₂ from ash samples is dried in a furnace at a temperature of 800°C at a temperature of 100°C/hour (calcination process), (vi) magnetic properties analysis test including Vicinity Magnetic Induction (VMI) and magnetic flux.

3. Result and Discussion
Samples of silicon dioxide from the reeds were characterized using an LCR meter in the frequency range of 50 Hz to 5 MHz. Measurements were carried out as many as 200 points on each sample. The characterization data will display several values, such as the value of frequency, charge, and inductance. These values can be used to calculate and analyze the magnetic properties of the sample. The frequency value \( f \) can be used to calculate the value of the angular velocity \( \omega \) using equation 1:

\[
\omega = 2\pi f
\]  

(1)

Next, the charge value \( Q \) is used to calculate the internal current with equation 2:

\[
I = \frac{Q}{t}
\]  

(2)

Where \( t \) is the time required to obtain 200 data points from the LCR meter. The following is a graph between the angular velocity value and the current value.

![Figure 1. Electrical current as function of angular velocity](image)

Figure 1 shows the electric current data against the angular velocity of 0 rad/s – 100000 rad/s SiO₂ at annealing temperatures of 500 °C, 600 °C and 700 °C of reeds. Based on the resulting pattern, it shows that the higher the angular velocity, the higher the value of the electric current. Samples treated with annealing temperature of 500 °C had the highest electric current value than samples treated with annealing temperatures of 600 °C and 700 °C.
The value of the electric current can be used to calculate the value of the surrounding magnetic induction in the sample [12]. The resulting ambient magnetic field is known as Vicinity Magnetic Induction (VMI). Based on Biot Savart’s law, we can calculate the VMI value using equation 3:

$$B = \frac{\mu_0 I}{2\pi r}$$  \hspace{1cm} (3)

The relations between the angular velocity value and the VMI value is shown in Figure 2. The VMI graph pattern is directly proportional to the current graph pattern. Figure 2 shows that the VMI value of each sample increases as the angular velocity value increases. This may indicate that the sample circuit is capacitive. The VMI values of the annealing temperature treatment samples of 500 °C, 600 °C and 700 °C are on the order of 10^{-7} – 10^{-6} tesla. The highest VMI value is shown in the annealing temperature treatment sample of 500 °C.

**Figure 2. Vicinity Magnetic Induction as a function of angular velocity**
In addition to current and VMI data, the inductance value is also measured on the LCR meter which can be used to calculate the magnetic flux value in each sample. The value of magnetic flux is shown in figure 3 in the angular velocity range of 0 rad/s – 7000 rad/s. The results obtained show that the graph fluctuates at angular velocities below 1000 rad/s, while at angular velocities above 1000 rad/s the magnetic flux values tend to be constant.

4. Conclusion
Based on the results of the analysis of magnetic properties show that the value of Vicinity Magnetic Induction (VMI) calculated on silicon dioxide samples from rice straw with order $10^{-7} - 10^{-6}$ tesla and magnetic flux values calculated on samples with order $10^{2} - 10^{4}$ weber on all annealing temperature variation at 500 °C, 600 °C, and 700 °C. Application of magnetic properties in the form of Vicinity Magnetic Induction (VMI) and magnetic flux of silicon dioxide from rice straw is the forerunner as a magnetic sensor.

Acknowledgments
This research was funded by Hibah Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT) from Deputy of Research and Development, Ministry of Research and Technology/National Research and Innovation Agency of Republic Indonesia with contract number: 1/E1/KP.PTNBH/2021 dated March 8th, 2021.

References
[1] Askwar, H, Jong-Kil, K, Pradip, BS, Dang, VQ, Godlisten, NS, Gideon, E, & Hee, TK. Synthesis of mesoporous silica with superior properties suitable for green tire , Journal of Insudtrial and Engineering Chemistry, 18, 1841-1844.2012.
[2] Wanvimon, A, Nuchanat, N, & Garry, LR.2004. Application of rice husk ash as fillers in the natural rubber industry. Journal of Applied Polymer Science, 98, 34-41. 2005.
[3] Suka G I, Simanjuntak W , Sembiring S, Trisnawati E. Karakteristik silika sekam padi dari provinsi Lampung yang diperoleh dengan metode ekstraksi. Jurnal MIPA. 37 (1):47-52.2008.
[4] Nazopatul, PH, Irzaman, & Irmansyah. Crystallinity and electrical properties of silicon dioxide
(SiO$_2$) from rice straw. *AIP Conference Proceedings*, 2202, 020028, 2019.

[5] Aminullah, E. Rohaeti, B. Yuliarto, & Irzaman. Reduction of silicon dioxide from bamboo leaves and its analysis using energy dispersive x-ray and fourier transform-infrared. *IOP Conference Series: Earth and Environmental Science*, 209, 012048, 2018.

[6] Irzaman, Novi, O. & Irmansyah. Ampel bamboo leaves silicon dioxide (SiO$_2$) extraction. *IOP Conference Series: Earth and Environmental Science*. 141 012014, 2018.

[7] Sintha, I, Dahrul, M, Ismawati, S.S., Kurniati, M., Irmansyah, & Irzaman, Optimalization of silicon extraction from husk ashes by excessive magnesium addition on increasing rate of temperature reduction. *Earth and Environmental Science*, 65 012032, 2017.

[8] Irzaman, Indah, DC, Aminullah, Akhirudin, M, Brian, Y, & Ulfah, S. Biosilica properties from rice husk using various HCl concentrations and frequency sources. *Egyptian Journal of Chemistry In press*.

[9] Casnan, Erliza, N, Hartrisari, H, Irzaman, & Eti, R. Scalling up of the phyrolysis to produce silica from rice husk, *Journal Engineering Technology*, 51 (6), 747-761, 2019.

[10] M. Z. Adli, Y. W. Sari, & Irzaman, Extraction silicon dioxide (SiO$_2$) from charcoal of baggase (Saccharum officinarum L), *IOP Conference Series: Earth and Environmental Science*, 187, 012004, 2018.

[11] MF Anuar, YW Fen, MHM Zaid, & NAS Omar. Optical studies of crystalline ZnO-SiO$_2$ developed from phyrolysis of coconut husk, *Material Research Expres in press*.

[12] Vania, R, Endah, KP, Nazopatul, P, Tony, S.& Irzaman. 2020. *Engineering Materials* (pp 197-201). Trans Tech Publication.