# Production of carbon nanotubes: Chemical vapor deposition synthesis from liquefied petroleum gas over Fe-Co-Mo tri-metallic catalyst supported on MgO

P. Setyopratomo, Praswasti P. D. K. Wulan, and M. Sudibandriyo

Citation: AIP Conference Proceedings **1737**, 030007 (2016); doi: 10.1063/1.4949287
View online: http://dx.doi.org/10.1063/1.4949287
View Table of Contents: http://scitation.aip.org/content/aip/proceeding/aipcp/1737?ver=pdfcov
Published by the AIP Publishing

# Production of Carbon Nanotubes: Chemical Vapor Deposition Synthesis from Liquefied Petroleum Gas over Fe-Co-Mo Tri-metallic Catalyst Supported on MgO

P. Setyopratomo[1,a)], Praswasti P.D.K. Wulan[1,b)], M. Sudibandriyo[1,c)]

[1]*Chemical Engineering Department, University of Indonesia, Depok Campus, Depok 16424, Indonesia*

[a)]Corresponding author: puguh_sptm@yahoo.com
[b)]wulanmakmur@gmail.com
[c)]msudib@che.ui.ac.id

**Abstract.** Carbon nanotubes were produced by chemical vapor deposition method to meet the specifications for hydrogen storage. So far, the various catalyst had been studied outlining their activities, performances, and efficiencies. In this work, tri-metallic catalyst consist of Fe-Co-Mo supported on MgO was used. The catalyst was prepared by wet-impregnation method. Liquefied Petroleum Gas (LPG) was used as carbon source. The synthesis was conducted in atmospheric fixed bed reactor at reaction temperature range 750 – 850 $^{o}$C for 30 minutes. The impregnation method applied in this study successfully deposed metal component on the MgO support surface. It found that the deposited metal components might partially replace $Mg(OH)_2$ or MgO molecules in their crystal lattice. Compare to the original MgO powder; it was significant increases in pore volume and surface area has occurred during catalyst preparation stages. The size of obtained carbon nanotubes is ranging from about 10.83 nm OD/4.09 nm ID up to 21.84 nm OD/6.51 nm ID, which means that multiwall carbon nanotubes were formed during the synthesis. Yield as much as 2.35 g.CNT/g.catalyst was obtained during 30 minutes synthesis and correspond to carbon nanotubes growth rate of 0.2 μm/min. The BET surface area of the obtained carbon nanotubes is 181.13 $m^2$/g and around 50 % of which is contributed by mesopores. Micropore with half pore width less than 1 nm contribute about 10% volume of total micro and mesopores volume of the carbon nanotubes. The existence of these micropores is very important to increase the hydrogen storage capacity of the carbon nanotubes.

## INTRODUCTION

The increase in global temperature in the last ten years due to increasing concentrations of greenhouses gasses (GHG) in the atmosphere [1]. The main source of GHG is the combustion of fossil fuels such as petroleum, natural gas and coal for power generation, industry and transport [2]. Hydrogen can be a promising alternative energy source in the future. Besides categorized as a clean fuel due to release non-GHG, it has a high calorific value which is approximately 2.75 times greater than the heating value of hydrocarbon fuels [3]. Development of safe and reliable hydrogen storage technology which also meet the criteria of performance and economic viability is critical to use hydrogen as a fuel for motor vehicles, industry and power plants. Carbon nanotubes (CNT) is seen as a potential medium for hydrogen storage because it has a lot of inner space as well as the space formed between the tubes which can adsorb hydrogen [4].

In chemical vapor deposition (CVD) method, carbon nanotubes were produced from the decomposition of carbon-containing compounds such as hydrocarbons and carbon monoxide [5]. Synthesis of carbon nanotubes using various carbon sources such as methane, ethylene, acetylene, ethanol, natural gas, etc. has been widely carried out which produces diverse morphology, size, and purity of CNT products. One alternative source of carbon is liquefied

*Proceedings of the 3rd AUN/SEED-NET Regional Conference on Energy Engineering and the 7th International Conference on Thermofluids (RCEnE/THERMOFLUID 2015)*
AIP Conf. Proc. 1737, 030007-1–030007-10; doi: 10.1063/1.4949287
Published by AIP Publishing. 978-0-7354-1391-7/$30.00

petroleum gas (LPG). LPG is a mixture of light hydrocarbons mainly propane and butane and contains a little amount of sulfur. The advantages of LPG as a carbon source is readily available in the market so that it can be obtained easily, and the price is much cheaper than other carbon sources in pure form. Huang et al. [6] and Zhang et al. [7] has been successfully synthesizing CNT using LPG as a carbon source, but still get a low rate of growth of CNT.

Transition metals consisting of Fe, Co, Ni, either in single or mixtures of them is generally used as a catalyst that acts as the active components. To increase its mechanical strength and specific surface area, the catalyst was deposited on porous media such as MgO, $Al_2O_3$, $SiO_2$, $CaCO_3$, which acts as a catalyst support [8]. It has been revealed that the metal is used and its loading, reaction temperature, and catalyst support are the variable which is considered controlling the quality (diameter, thickness, the degree of graphitization, purity) and yield of CNT [9]. Moreover, both of quality and yield were also influenced by the diameter of the metal and the degree of dispersion [8]. Observation has proved that the catalyst performance could be improved drastically by mixing two or more metal. Besides improving the quality of the resulting CNT, this action will also reduce the reaction temperature [10].

One of the requirements of a good support material is easily separated from the product CNT. In this case, MgO was considered superior to others because it can be removed only by a simple acid treatment [11]. It was also reported that the use of MgO-supported Fe has shown excellent performance. The strong interaction between the MgO support and the metal which resulted in the good dispersion of the metal catalyst was considered to be the determining factor [12].

In the case of metal component Fe, Co, and Mo, each component has its role and advantages. Fe active component is capable of producing higher yields than Co and Ni [8,13] and produces CNT with high density, the density of single-wall carbon nanotubes (SWCNT) are greatly influenced by the catalyst used in the order of Fe> Co >> Ni≈ Cu [11]. The active component Co can improve the quality of CNT in term of graphitization and structure [14]. Mo acts as promoter and activator, demonstrate synergy with other metals to increase the yield and improve the CNT morphology [15] and to prevent very rapid deactivation of the catalyst [8,16,17].

The addition of Molybdenum could enhance the synergism among the mixture of Fe or Co metal catalyst. The role of Mo would be as a promoter or activator which will improve the catalyst performance in term of increasing the yield, produce better CNT morphology [10,15]. Wei [18] was reported that the addition of Mo to Fe metal catalyst will prevent sintering of Fe metal catalyst, so the presence of both metals in the catalyst system will prevent rapid deactivation of the catalyst due to sintering. It was also reported that the addition of Mo to Co will stabilize the Co species and avoid agglomeration. However, the addition of Mo in the tri-metallic catalyst system is still not widely observed.

To date, the use of a catalyst comprising of more than two metal components is still rare. In this present study a combination of three metal components, consisting of Fe, Co, and Mo which were deposited on MgO as the support was used as a catalyst. The objective of the study is to investigate the catalyst activity, performance and efficiency resulting from the interaction of the three components of metal, in synthesizing of CNT by chemical vapor deposition using LPG as the carbon source.

## EXPERIMENTAL

### Catalysts Preparation

Tri-metallic catalysts, with wt.% proportions of Fe:Co:Mo:MgO (2:2:1:95) were prepared using a wet chemical impregnation method. In such synthetic procedure, 4,7500 g MgO were dispersed in 95 ml of distilled water and the suspension was sonicated for 10 minutes, followed by stirring for 60 min in order to produce a homogeneous suspension. Appropriate amounts of aqueous solutions of metals nitrate $Fe(NO_3)_3.9H_2O$, $Co(NO_3)_2.6H_2O$ and $(NH_4)_6Mo_7O_{24}.4H_2O$ were then added to the MgO suspension, and the mixture was further stirred for 30 min. The final mixture was dried at 110 $^oC$ under vacuum, collected and grounded into fine powder. The dried catalyst then placed in an electric furnace to undergo calcination process at 500 $^oC$ for 4 hours.

## CNT Synthesis

CNT synthesis was performed in the electrically heated atmospheric fixed bed reactor. The reactor made from quartz tube with 1.6 cm inner diameter and 25 cm length. At the bottom of the reactor was fitted quart wool which serves as a gas distributor and maintains the catalyst in place. As much as 200 mg of the calcined catalyst powder were poured over the quartz wool. At a distance of 10 cm above the catalyst was also fitted quartz wool to prevent the entrainment of the catalyst out of the reactor follow the flow of the effluent gas. The reactor was then heated to 450 $^{o}$C for 5 h under hydrogen atmosphere for undergoing catalyst reduction process. The temperature then rises to 750 – 850 $^{o}$C for CNT synthesis. When the required temperature was achieved, LPG as a carbon source was admixed with the carrier gas (hydrogen and argon) at flow rates of 25, 19, and 150 cc/min, respectively, and is fed through the bottom of the reactor. The synthesis was performed for 30 minutes. After synthesis lasts for 30 minutes, the reaction is stopped by turning off the flow of LPG and hydrogen. The reactor is then cooled to room temperature with argon gas flow.

## Characterization Techniques

The characteristic of the catalyst was evaluated by X-ray diffraction and nitrogen adsorption isotherms. The carbon nanotubes diameter and morphology were analyzed by Transmission Electron Microscope (TEM) and Field Emission Scanning Electron Microscope (FE-SEM). While the carbon nanotubes pore structure and volume were characterized by nitrogen adsorption isotherm.

# RESULT AND DISCUSSION

## Chemical Characterization of the Catalyst

In this study, the impregnation method was applied to prepare the catalyst with designed metal loading to be 5 %w with metal composition Fe:Co:Mo = 2:2:1 %w. That means that the weight per cent of all reduced metal components which include Fe, Co, and Mo would be 5 %w of the total catalyst weight. To confirm the composition, X-ray fluorescence. (XRF) analysis was performed. The reduced catalyst sample was characterized using SPECTRO X-Lab Pro X-ray fluorescence spectrometer. The result of the analysis was exposed on Table 1. It can be seen that the component weight ratio close to the designed composition. This provides an indication that the impregnation method applied in this study successfully deposed metal component on the MgO support surface.

**TABLE 1.** X-ray fluorescence analysis result of reduced catalyst

| Component | Concentration (%w) | Weight Ratio |
|---|---|---|
| MgO | 92.80726 | 93.97 |
| Fe | 2.78000 | 2.81 |
| Co | 2.27900 | 2.31 |
| Mo | 0.90110 | 0.91 |
| | Total | 100 |

To further detect the state of the metal components in the MgO support, X-ray diffraction (XRD) analysis was performed. The X-ray diffraction analysis of the catalyst samples was carried out in a Panalytical X'pert Pro diffractometer equipped with a Cu $K\alpha_1$, $K\alpha_2$, $K_\beta$ source ($\lambda$ = 0.154060 nm, 0.154443 nm, 0.139225 nm, respectively) and a power setting of 40 kV and 30 mA. The patterns were recorded in the 2-theta (2$\theta$) range from 10.0084$^{o}$ to 89.9764$^{o}$ in steps of 0.0170$^{o}$ and counting time 10.16 s per step. To investigate whether there are any phase transitions during the catalyst preparation step, XRD analysis was performed for a series of samples includes the original MgO powder, the catalyst sample after the deposition of metal components which have been dried (dried catalyst), the catalyst sample after calcinations (calcined catalyst) and the catalyst sample after the reduction process (reduced catalyst). The XRD pattern corresponds to the series of the samples were shown on Fig. 1. As shown in the pattern,

the original MgO powder comprises of $Mg(OH)_2$ (brucite) and MgO (periclase) phase. According to the analysis record the composition is comprised of 72%w $Mg(OH)_2$ and 28%w MgO. The crystal system of $Mg(OH)_2$ is hexagonal whose cell volume of $40.94 \times 10^{-6}$ $pm^3$, while MgO has cubical crystal system whose cell volume of $75.53 \times 10^{-6}$ $pm^3$. The density of crystalline $Mg(OH)_2$ and MgO is 2.36 and 3.58 g $cm^{-3}$, respectively. In dried catalyst, it found that only $Mg(OH)_2$ phase was detected. It shows that the interaction between MgO particles and water during preparation of MgO slurry before metal deposition lead to rehydration of MgO to $Mg(OH)_2$. Furthermore, $H_2O$ release or dehydration occurs in the calcination stage due to heat treatment, thus only MgO phase was detected in the calcined catalyst. The level of temperature needed for complete conversion of $Mg(OH)_2$ to MgO was affected by the dispersion of the original $Mg(OH)_2$ crystals and the efficiency of $H_2O$ removal. It was reported that temperatures level of 350–450 $^oC$ are sufficient to achieve the decomposition in a reasonable time of about 1–10 h [19]. Further heat treatment during catalyst reduction stage does not cause any phase transition and formation, this is shown by the resulted pattern which confirms that the only detected phase in the reduced catalyst is MgO.

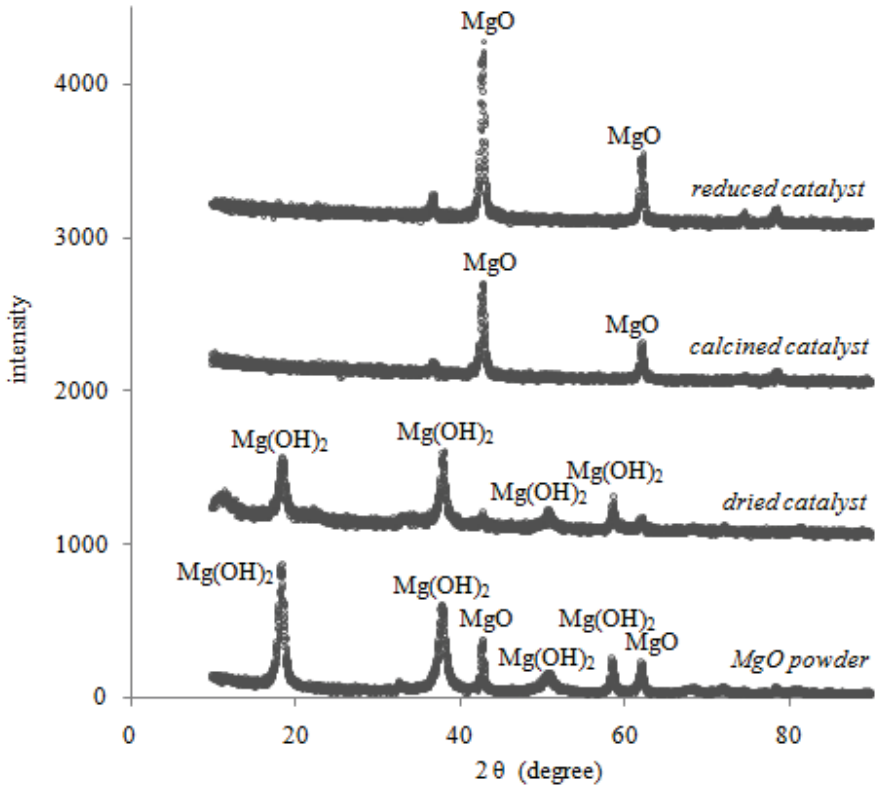



**FIGURE 1.** XRD pattern of the original MgO powder and the catalyst samples

In reality, in the XRD pattern, it was not detected the formation of a new phase containing the deposited metal components, either after the deposition process (dried catalyst) nor after calcination and reduction stage. This fact indicates that the deposited metal components might partially replace $Mg(OH)_2$ or MgO molecules in their crystal lattice. This phenomenon has strengthen opinion that there is a strong metal-support interaction between MgO support and the metal components. It was also reported that Fe is able to dissolve into MgO support and dispersed evenly during the impregnation process [20].

## Physical Characterization of Catalyst

Besides the chemical composition, the porosity and the surface area of the supported catalyst could also affect the catalytic performance of supported species. Some studies have attributed the influence of pore size on the catalytic activity to mass transport phenomena. More recently, the effect of intra-particle pore diffusion limitations on the catalyst productivity and the role of catalyst porosity on mass transfer have been observed [21]. Because of the

importance of porosity and surface area of catalyst in catalytic processes, in this work physical characterization of such physical properties were carried by nitrogen adsorption-desorption isotherm method using Quantachrome NovaWin - data acquisition and reduction for quanta chrome instruments version 11.03. The results of the analysis are shown in Table 2. It can be seen that the mesopores which were determined by BJH method give a dominant contribution to the total pore volume of the catalyst, on the other hand, micropores volume measured by HK method has a very small proportion. It was also shown that there is no significant change in pore radius during the whole series of catalyst preparation stages. Compare to the original MgO powder, it was observed significant increases in pore volume and surface area during the catalyst preparation stages. It was reported that about 50% contraction of the lattice happens in dehydration which leads to the development of cracks and crystal disintegration. This incident results in surface area increase during $Mg(OH)_2$ calcination [19]. Such cracking and crystal disintegration may also be a cause of the increasing pore radius after calcination. .

**TABLE 2.** Porosity and surface area of the catalyst

| Sample | Avg Pore Radius | Pore Volume | | | Surface Area | |
|---|---|---|---|---|---|---|
| | | BJH Method | HK Method (micropores) | Total Pore Volume | BJH Method | BET Method |
| | (nm) | cc/g | cc/g | cc/g | $m^2/g$ | $m^2/g$ |
| MgO powder | 14.29 | 0.183 | 0.010 | 0.191 | 13.808 | 26.744 |
| Dried catalyst | 12.81 | 0.450 | 0.030 | 0.473 | 42.060 | 73.850 |
| Calcined catalyst | 16.31 | 0.409 | 0.021 | 0.416 | 30.672 | 51.055 |
| Reduced catalyst | 14.15 | 0.390 | 0.022 | 0.399 | 34.713 | 56.457 |

## Carbon Nanotubes Morphology and Diameter

Morphology of the CNT was analyzed using FE-SEM and the image is presented in Fig. 2. As can be seen, entangled CNT were formed. There is no clear indication of the formation of amorphous carbon. This fact indicate that the deactivation of the catalyst has not happened, then the addition of the reaction time is still great potential for increasing the yield. A strong interaction between MgO with active components may be the factor that makes the catalyst dispersed quite well and were stable at high temperatures so that its activity can be maintained. Co role as a promoter is also shown by the capability protecting the catalyst from sintering at high temperatures so that the growth of CNT do not undergo a termination. While TEM analysis was performed to observe the diameter and structure of the CNT. The TEM image was shown in Fig. 3. It can be seen, from the TEM image, that the size of CNT is ranging from about 10.83 nm OD/4.09 nm ID up to 21.84 nm OD/6.51 nm ID. It means that multi-wall carbon nanotubes (MWCNT) were formed during the synthesis. Taking into account the distance between the CNT layer which is 0.34 nm, it means that the number of the wall formed were in the range 20 – 45 walls. This lack of uniformity in term of the CNT diameter can occur due to the influence of individual characteristics of the components Fe and Co, one between the two components might tend to form a CNT with a smaller diameter. CNT obtained in this work has smaller outer diameter than produced by Zhang *et al.*, which produce CNT from LPG having an outer diameter around 35 nm [7]. From the image, we can also observe that some of the formed individual CNT have carbon blockage in its inner space instead of fully interconnected inner hole along CNT. The very high activity of the catalyst in decomposing hydrocarbons, so that the rate of deposition of carbon into the CNT network was not able to counterbalance the carbon decomposition rate, may cause the formation of such carbon blockage.

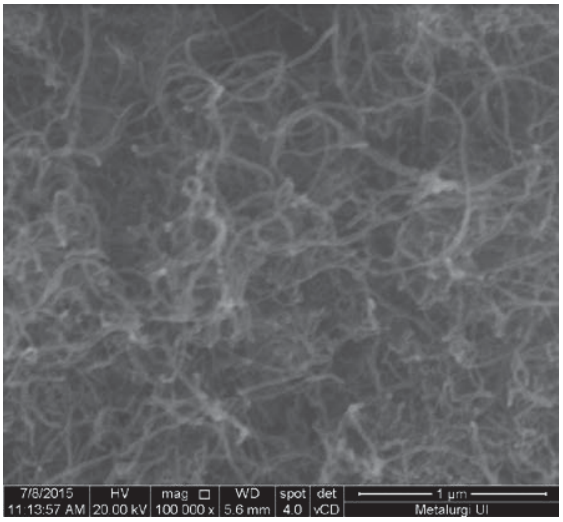



**FIGURE 2.** FE-SEM image of the CNT product

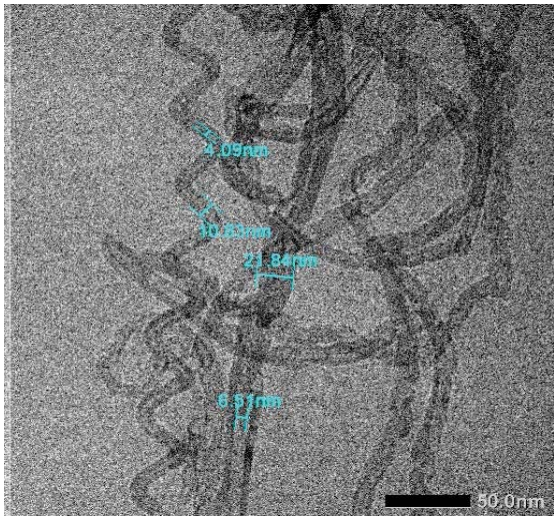



**FIGURE 3.** TEM image of the CNT product

## Yield and Growth Rate of the CNT

Catalyst activity in CNT synthesis reaction can be observed by determining the yield of CNT produced. The CNT yield is expressed in mass of CNT produced per unit mass of catalyst. The mass of catalyst used is determined from the difference between the total mass of the reactor after and before feeding of the catalyst. The mass of reactor was measured by weighing its weight on an electric balance. In this case, the external and internal mass transfer is assumed not a limiting factor for the overall rate of reaction. Then the yield is practically only affected by the catalyst activity in decomposing hydrocarbons as well as in CNT formation and growth. Mass of the CNT was obtained by counting the difference of reactor weight after and before CNT synthesis. In this work, during 30 minutes reaction, the yield of 2.35 g.CNT/g.catalyst was obtained. In that period CNT around 5 µm in length could be formed, which correspond to the CNT growth rate of 0.2 µm/min. This value is much less than the results achieved by Zhang *et al.* which can reach a growth rate of 1.5 µm/min in the synthesis of CNT from LPG using a floating catalyst [7].

## Physical Characterization of the Carbon Nanotubes

*Nitrogen Adsorption-desorption Isotherm*

Nitrogen adsorption isotherm profile of porous materials is the most common information use to determine the surface and internal structure properties of porous solid. Some pore characteristics that can be derived from such profile include specific surface area, pore size distribution, pore connectivity, surface chemistry, and the area density of any surface functional groups [22].

The adsorption isotherm was obtained by measuring the amount of $N_2$ adsorbed on CNT sample across 0 - 1 relative pressures at a constant temperature 77.350 K. Conversely, desorption isotherm was achieved by measuring gas removed as pressure is reduced. The isotherms, which are obtained using the quantachrome instruments, such as used for catalyst analysis, are shown in Fig. 4, in which P is the equilibrium pressure and Po is the saturation pressure. It seems follow type IV isotherm which occurs on porous adsorbents with pores in the range of 1.5 – 100 nm. The isotherm type is observed where at higher pressure the slope shows increased uptake of adsorbate as pores become filled. The capillary condensation below the expected condensation pressure of the adsorbate is considered as cause the increase in adsorbed volume at higher P/Po in type IV isotherms. Capillary condensation requires pre-formation of adsorbate layer on the pore walls formed by multilayer adsorption, which usually occur in the region of 0.3 – 1 P/Po [23].

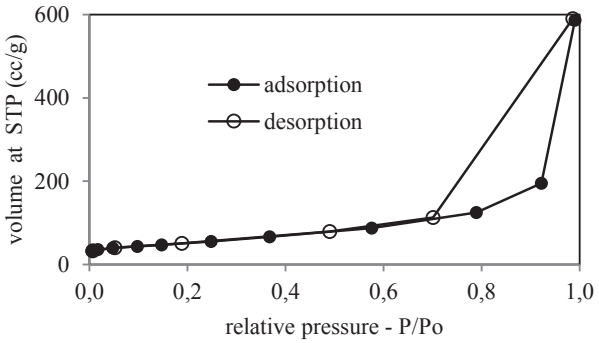



**FIGURE 4.** Nitrogen adsorption-desorption isotherm profile

*Surface Area Analysis*

The surface area is formed by surface irregularities and the presence of pores interiors. The surface area can be determined on the atomic level by the adsorption of an un-reactive or inert gas. Besides determined by the amount of the exposed surface, the amount of adsorbed gas is also influenced by (i) temperature, (ii) gas pressure and (iii) the strength of the interaction between the gas and solid. In fact, most gasses and solids interact weakly by van der Waals forces, then the surface must be cooled significantly to be able to adsorb measurable amount of gas. When the gas pressure is raised, after monolayer formation is completed, excess gas adsorption will continue to form a multilayer. The Brunauer-Emmett-Teller (BET) method is the most widely used procedure for the determination of the surface area of porous materials. The result of carbon nanotubes surface area by multi-point BET analysis was presented in Table 3.

**TABLE 3.** Result of carbon nanotubes BET surface determination

| P/Po | 1 / [ W((Po/P) – 1) ] |
|---|---|
| 0.0090 | 0.2136 |
| 0.0173 | 0.3904 |

| | |
|---|---|
| 0.0476 | 1.0058 |
| 0.0974 | 1.9814 |
| 0.1469 | 2.9242 |
| 0.2479 | 4.7887 |

where, $P/P_o$: relative pressure and W: weight of gas adsorbed. From these data, it was obtained the specific surface area = 181.13 $m^2/g$. The surface area is comparable with were obtained by C. Kuo et al. (82.2 $m^2/g$) [24] and C. Wu (106.9 $m^2/g$) [25].

*Pore Size Distribution – BJH Method*

According to IUPAC recommendation, pores are classified according to their sizes: macropores for pore diameter greater than 50 nm, mesopores for pore diameter range between 2 – 50 nm, and micropores for pore diameter less than 2 nm. Gas adsorption studies can characterize the porosity of powders and other porous solids. There are two common ways of describing porosity: (1) determination of total pore volume and (2) measurement of pore size distribution.

The pore size distribution (PSD), which provides information about pore volume as a function of pore diameter, is the most important textural properties of the porous material. Nitrogen adsorption– desorption isotherm data at 77 K is the most used method to obtain the PSD. Barrett, Joyner and Halenda (BJH) are the first one who proposed a method to determine PSD for mesopores size calculations, based on the capillary condensation theory, built upon cylindrical pore geometry assumption, and used Kelvin equation [26].

BJH pore size distribution of CNT produced in this study was presented on Table 4. It was shown that the total pore volume of mesopores was 0.8480 cc/g correspond to pore radius range 2.8 – 35.8 nm. The distribution profile also suggests that the mesopores contribute 95.310 $m^2/g$ of pores surface area.

**TABLE 4.** BJH pore size distribution

| **Pore Radius (r)** | **Cumulative Pore Volume (V)** | **Cumulative Pore Surface Area (S)** | **dV(r)** | **dS (r)** |
|---|---|---|---|---|
| nm | cc/g | $m^2/g$ | cc/nm/g | $m^2/nm/g$ |
| 2.8 | 0.0717 | 51.968 | 0.0458 | 33.1960 |
| 35.8 | 0.8480 | 95.310 | 0.0120 | 0.6713 |
| 85.2 | 0.8480 | 95.310 | 0.0000 | 0.0000 |

*Micropore Volume Characterization – HK Method*

The quantitative determination of pore size distribution for micropores solid still a crucial problem. Although some methods suitable for meso and macropores characterization, such as BET and BJH method, the application of such method to micropores materials has not generated a satisfactory result. The main reason is the adsorbate molecules can no longer be treated in a fluid state if the pore size less than 2 nm and attractive force in molecular level become important to be taken into account [27]. Then, the measurement of micropores distribution in porous adsorbent and catalyst still become a challenge. Horvath and Kawazoe (HK) proposed a classical thermodynamic approach for PSD analysis which is mostly applied to micropores range. The model was originally developed for slit shape pores which assumed a linear Henry's law isotherm [22]. The fundamental concept of HK model is correlate the micropores filling pressure to the solid-fluid interaction potential [28]. For strictly microporous material, the HK model generates nearly identical results obtained from the Density Functional Theory (DFT), which is considered as the new and most sophisticated method of the determination of microporosity [29]. The result of micropores volume distribution measurement of CNT product is shown in Fig. 5. It shows that the cumulative micropore volume is 0.074 cc/g for half

pore width ranging from about 0.18 – 1.00 nm. Moreover, micropores with a size of less than 0.2 nm dominate as indicate by the contribution of more than half of the volume of micropores. Compare to the results of mesoporous volume determined by BJH method, microporous and mesoporous volume ratio is approximately 1: 10. It means that micropore with half pore width less than 1 nm contribute about 10% volume of total micro and mesopores volume.

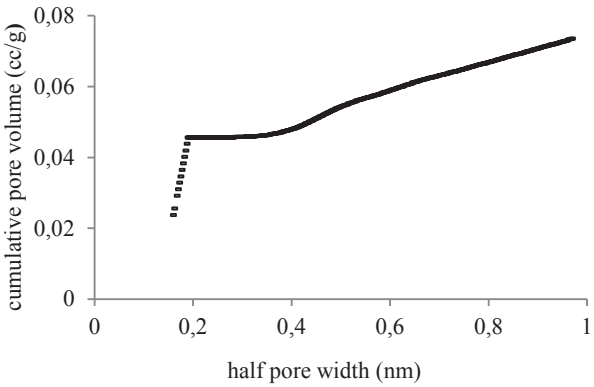



**FIGURE 5.** Micropore volume distribution

The presence of micropores in the CNT is the advantage regarding the application of the CNT as hydrogen storage, since the existence of these micropores will increase the hydrogen storage capacity of the carbon nanotubes. The MWCNT with narrowest micropores will have the highest hydrogen adsorption potential [4].

## CONCLUSION

The X-ray fluorescence analysis has shown that the impregnation method applied in this study successfully deposed metal component on the MgO support surface. No formation of a new phase of the deposited metal components, neither after the deposition process (dried catalyst) nor after calcination and reduction stage, indicates that the deposited metal components might partially replace $Mg(OH)_2$ or MgO molecules in their crystal lattice. Compare to the original MgO powder. It was observed significant increases in pore volume and surface area during the catalyst preparation stages. Contraction of the lattice which happens in dehydration cause the development of cracks and crystal disintegration leading to an increase in surface area during $Mg(OH)_2$ calcination. Analyzed CNT product using FE-SEM has shown that entangled CNT was formed. The size of obtained CNT is ranging from about 10.83 nm OD/4.09 nm ID up to 21.84 nm OD/6.51 nm ID, which means that MWCNT were formed during the synthesis. Yield as much as 2.35 g.CNT/g.catalyst was obtained during synthesis time of 30 minutes and correspond to CNT growth rate of 0.2 μm/min. The BET surface area of the obtained CNT is 181.13 $m^2$/g and around 50 % of which, which is 95.310 $m^2$/g, is contributed by mesopores. Micropore with half pore width less than 1 nm contribute about 10% volume of total micro and mesopores volume of the produced CNT. The existence of these micropores is very important to increase the hydrogen storage capacity of the carbon nanotubes.

## ACKNOWLEDGMENTS

The authors wish to thank The Directorate Research and Community Services, University of Indonesia, for providing the financial support through The Postgraduate Research Grant 2015.

## REFERENCES


1. R., Sathre, *Fuel*, **115** (2014) 674
2. H.F., Abbas and W.M.A.W., Daud, *Int. J. of Hydrogen Energy*, **35** (2010) 1160.
3. I.K., Kapdan and F., Kargi, *Enzyme and Microbial Technology*, **38** (2006) 569
4. S., Lee and S., Park, *J.of Solid State Chemistry*, **194** (2012) 307
5. E., Couteau, K., Hernadi, J.W., Seo, L., Thien-Nga, C., Mik, R., Gaal and L., Forr, *Chemical Physics Letters*, **378** (2003) 9.
6. J., Huang, Q., Zhang, F., Wei, W., Qian, D., Wang and L., Hu, *Carbon*, **46** (2008) 291.
7. Q., Zhang, J., Huang, M., Zhao, W., Qian, Y., Wang, and F., Wei, *Carbon*, **46** (2008) 1152.
8. S.W., Jeong, S.Y., Son and D.H., Lee, *Advanced Powder Technology*, **21** (2010) 93.
9. S., Tang, Z., Zhong, Z., Xiong, L., Sun, L., Liu, J., Lin, Z.X., Shen and K.L., Tan, *Chemical Physics Letters*, **350** (2001) 19.
10. A., Dupuis, *Progress in Materials Science*, **50** (2005) 929.
11. H., Ago, Y., Nakamura, Y., Ogawa and M., Tsuji, *Carbon*, **49** (2011) 176.
12. S.Y. Son, Y., Lee, S., Won and D.H., Lee, *Ind. Eng. Chem. Res*., **47** (2008) 2166.
13. M., Pérez-Cabero, I., Rodríguez-Ramos and A., Guerrero-Ruíz, *Journal of Catalysis*, **215** (2003) 305.
14. A., Fonseca, K., Hernadi, B., Nagya, D., Bernaerts and A.A., Lucas, *Journal of Molecular Catalysis A: Chemical*, **107** (1996) 159.
15. M., Pe´rez-Mendoza, C., Valle´s, W.K., Maser, M.T., Martı´nez, S., Langlois, J.L., Sauvajol and A.M., Benito, *Letters to the Editor / Carbon*, **43** (2005) 3002.
16. L. Ni, K., Kuroda, L., Zhou, T., Kizuka, K., Ohta, K., Matsuishi and J., Nakamura, *Carbon*, **44** (2006) 2265.
17. H., Ago, N., Uehara, N., Yoshihara, M., Tsuji, M., Yumura, N., Tomonaga and T., Setoguchi, *Carbon*, **44** (2006) 2912.
18. F., Wei, Q., Zhang, W., Qian, H., Yu, Y., Wang, G., Luo, G., Xu and D., Wang, *Powder Technology*, **183** (2008) 10.
19. M. Zdražil, *Catalysis Today*, **86** (2003) 151.
20. Z., Qiang, Z., Mengqiang, H., Jiaqi, Q., Weizhong, and W., Fei, *Chinese Journal of Catalysis*, **29** (2008) 1138.
21. K., Cheng, M., Virginie, V.V., Ordomsky, C. Cordier, P.A., Chernavskii, M.I., Ivantsov, S., Paul, Y., Wang and A.Y., Khodakov, *Journal of Catalysis*, **328** (2015) 139.
22. S.H. Madani, A. Badalyan, M.J. Biggs and P. Pendleton, *Microporous and Mesoporous Materials*, **214** (2015) 210.
23. S., Storck, H., Bretinger and W.F., Maier, *Applied Catalysis A: General*, **174** (1998) 137.
24. C. Kuo, C. Wu, J. Wu, *Journal of Colloid and Interface Science*, **327** (2008) 308.
25. C. Wu, *Journal of Hazardous Materials*, 144 (2007) 93.
26. J., Villarroel-Rocha, D. Barrera and K. Sapag, *Microporous and Mesoporous Materials*, **200** (2014) 68.
27. S.U. Rege and R.T. Yang, *AIChE Journal*, **46** (2000) 734.
28. R.J. Dombrowski, C.M. Lastoskie and D.R. Hyduke, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, **187–188** (2001) 23.
29. P. Kowalczyk, A.P. Terzyk, P.A. Gauden and L. Solarz, *Computers and Chemistry*, **26** (2002) 125.

Volume 2055

Conference collection

# Proceedings of the Europe/Africa Conference Dresden 2017 – Polymer Processing Society PPS


**Dresden, Germany**
27-29 June 2017

**Editors**
Udo Wagenknecht, Petra Pötschke, Sven Wiessner and Michael Gehde

AIP | Conference Proceedings

proceedings.aip.org

# AIP Conference Proceedings

**COUNTRY**

United States

Universities and research institutions in United States

**SUBJECT AREA AND CATEGORY**

Physics and Astronomy
└ Physics and Astronomy (miscellaneous)

**PUBLISHER**

American Institute of Physics

**H-INDEX**

75

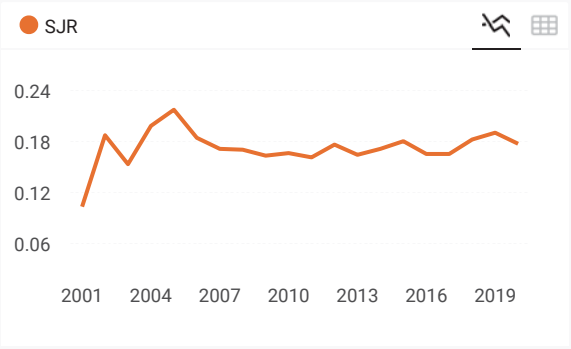
| | | | |
|---|---|---|---|
| Proceedings | | 1984, 1993, 2000-2001, 2003-2020 | How to publish in this journal<br>confproc@aip.org |

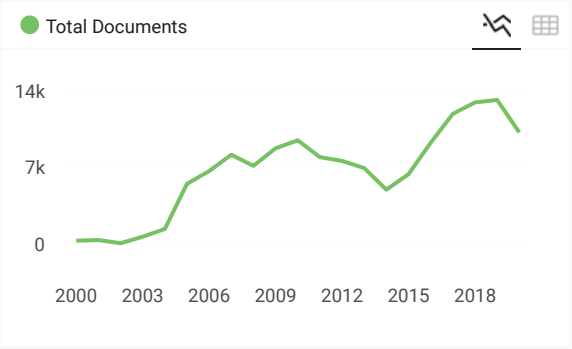
**SCOPE**

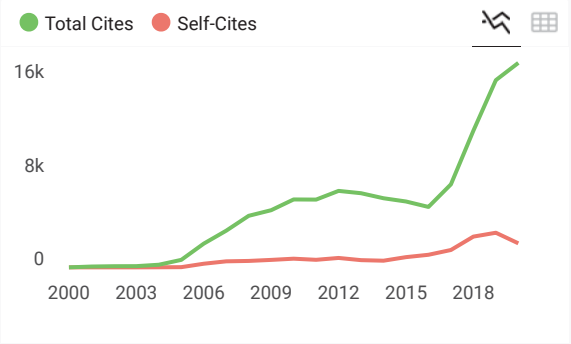
Today, AIP Conference Proceedings contain over 100,000 articles published in 1700+ proceedings and is growing by 100 volumes every year. This substantial body of scientific literature is testament to our 40-year history as a world-class publishing partner, recognized internationally and trusted by conference organizers worldwide. Whether you are planning a small specialist workshop or organizing the largest international conference, contact us, or read these testimonials, to find out why so many organizers publish with AIP Conference Proceedings.

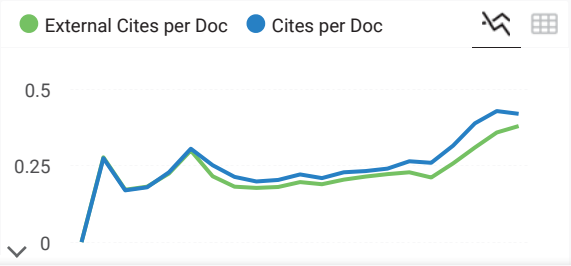
Join the conversation about this journal

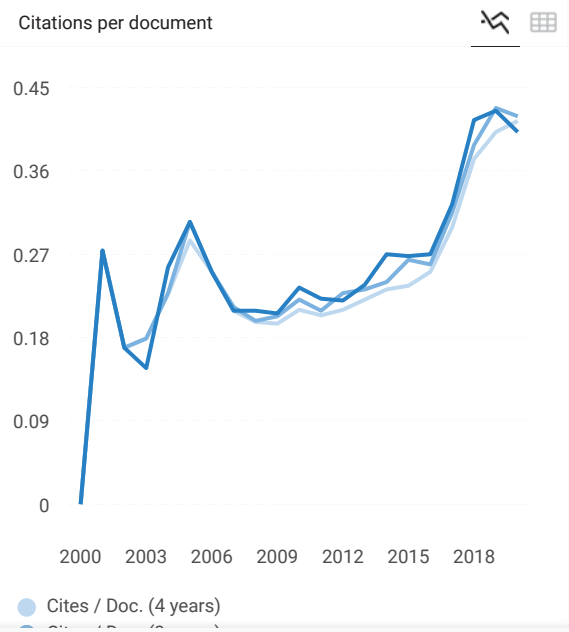


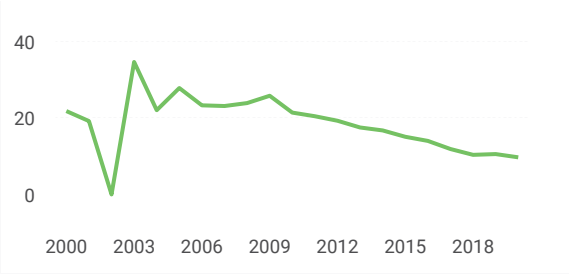


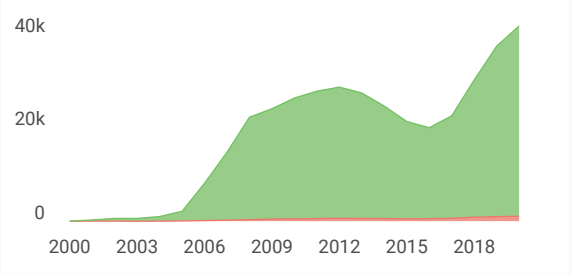



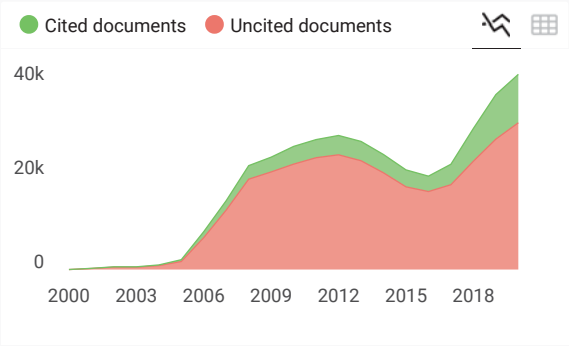







← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scimag



Metrics based on Scopus® data as of April 2021

**Ghazwan Jreou** 1 month ago

Dear sir
respects
would you please let me know in which Q is your journal (conferences and proceeding) classified?
according to Scopus Q classification list .
with regards.

reply

SCImago Team

**Melanie Ortiz** 1 month ago

A **ASHOK KUMAR K** 3 months ago

As per the information in SJR portal the coverage period for AIP conference proceedings is up to 2020. I want to know whether the period of validity or coverage gets extended or not? If gets extended when can we see those updates in the SJR portal?

reply

SCImago Team

**Melanie Ortiz** 3 months ago

Dear Ashok,
Thank you very much for your comment.
All the metadata have been provided by Scopus /Elsevier in their last update sent to SCImago, including the Coverage's period data. The SJR for 2019 was released on 11 June 2020. Therefore, the indicators for 2020 will be available in June 2021.
We suggest you consult the Scopus database directly to see the current index status as SJR is a static image of Scopus, which is changing every day.
Best Regards, SCImago Team

K **Kay** 6 months ago

My university is going to organise a conference in social science on 27-28 Oct 2021. We would like to publish our conference papers in your proceeding as our official proceeding. What are the procedures and publication fees?

Regards.

reply

SCImago Team

**Melanie Ortiz** 6 months ago

Dear Kay,
thank you for contacting us.
We are sorry to tell you that SCImago Journal & Country Rank is not a publication. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you visit the homepage or contact the editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

R **Ruslan** 7 months ago

I have published articles on AIP, but until now I have not received confirmation for my Scopus ID, please explain. thank you

SCImago Team

**Melanie Ortiz** 7 months ago

Dear Ruslan,
thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you contact Scopus support:
https://service.elsevier.com/app/answers/detail/a_id/14883/kw/scimago/supporthub/scopus/
Best Regards, SCImago Team

V

**Vikas** 11 months ago

currently, the journal is not assigned quartile (Q indexing). When we can expect the assignment.

reply

SCImago Team

**Melanie Ortiz** 11 months ago

Dear Vikas,
Thank you for contacting us. We calculate the SJR data for all the publication's types, but the Quartile's data are only calculated for Journals and Book Series.
Best regards, SCImago Team

S

**Siddik** 1 year ago

This will come under scopus journal list?

reply

SCImago Team

**Melanie Ortiz** 1 year ago

Dear Siddik,
Thank you very much for your comment.
All the metadata have been provided by Scopus /Elsevier in their last update sent to SCImago, including the Coverage's period data. The SJR for 2019 was updated on June 2020, 11. We suggest you consult the Scopus database directly to see the current index status as SJR is a static image of Scopus, which is changing every day.
Best Regards, SCImago Team

H

**Hassan Yassein** 1 year ago

ISSN of this journal different of ISSN in Scopus, although the data of SJR depends on the scopes

reply

SCImago Team

**Melanie Ortiz** 1 year ago

Dear Hassan,
Thank you for contacting us.
SJR is a portal with scientometric indicators of journals indexed in Scopus. All the data (Title, ISSN, etc.) have been provided by Scopus /Elsevier and SCImago doesn´t have the authority over this data which are property of Scopus/Elsevier. SCImago has a signed agreement that limits our performance to the generation of scientometric indicators derived from the metadata sent in the last update (April/May 2020).

The next SCImago update will be made throughout June 2020 with the new update sent by Scopus. We suggest you wait for that date in order to see if there are any changes regarding this matter.

Best Regards, SCImago Team

**Khairil** 1 year ago

Is this proceeding ranked Q4?

reply

A

**ali mohammed** 1 year ago

why this journal dont have any rank yet ?
it is dont belong to Q1,2,3,4 ?

reply

SCImago Team

**Melanie Ortiz** 1 year ago

Dear Ali,
Thank you for contacting us. We calculate the SJR data for all the publication types, but the Quartile data are only calculated for Journal type's publications. Best regards,
SCImago Team

A

**Akshya Sekar** 1 year ago

Hi mam/sir,
I want to know whether this AIP conference proceeding is indexed in SCI or not?

Thanks

reply

Dear Akshya,
Thank you for contacting us. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus. Unfortunately, we cannot help you with your request referring the index status. We suggest you to consult Scopus database (see the current status of the journal) or other databases (like WoS). Best Regards, SCImago Team

**Khairil** 2 years ago

Your IP (036.071.233.236) is blocked.
Block Reason: This IP was identified as infiltrated and is being used by sci-hub as a proxy.

How to unblock this my IP for acess AIP site?

thanks

reply

SCImago Team

**Melanie Ortiz** 2 years ago

Dear Khairil,
thank you for contacting us.
Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you to contact the journal's editorial staff by e-mail. Best Regards, SCImago Team

D

**Duha Ahmed** 2 years ago

dear Admin
about the AIP Conference Proceeding can you see the Scopus site because the date end to 2019 is there any update about this time or change it to 2020 in the near future and you will see it in the site of Scopus
https://www.scopus.com/sourceid/26916

I hope the AIP Conference Proceeding is still in the Scopus for 2020
with my best wishes
Miss Duha

reply

SCImago Team

**Melanie Ortiz** 2 years ago

Dear Duha,

M **mohammed** 2 years ago

Is the ( AIP Conference Proceeding ) out of Scopes because I tried to search for it in Scopes and I did not find it
Please answer me

reply

SCImago Team

**Melanie Ortiz** 2 years ago

Dear Mohammed,

thank you for contacting us. You can find it in Scopus:
https://www.scopus.com/sourceid/26916

Best Regards, SCImago Team

T **Thanh Quang Khai Lam** 2 years ago

Dear Elena Corera!
Can you tell me "Lecture notes in civil engineering" in Q4?
i don't see in Scimago.
Thank you

reply

SCImago Team

**Melanie Ortiz** 2 years ago

Dear Thanh,
Thank you for contacting us. We calculate the SJR data for all the publication types, but the Quartile data are only calculated for Journal type's publications. Best regards,
SCImago Team

T **Teo Jin Chuan** 2 years ago

Dear Admin,

Can i know is this journal Q1,Q2,Q3 or Q4. Thank you.

Regards

reply

SCImago Team

H **Hassan Abdulhadi** 3 years ago

I ASKE ABOUT AIP CONFERENCE PROCEEDINGS WITHIN SCOPUS OR THOMSON REUTERS WITH BEST WISHES

reply

H **Hassan Abdulhadi** 3 years ago

I ASKE ABOUT AIP CONFERENCE PROCEEDINGS WITHIN SCOPUS OR THOMSON REUTERS WITH BEST WISHES

SCImago Team

**Elena Corera** 3 years ago

Dear Hassan,

thank you for your request, all the journals included in SJR are indexed in Scopus. Elsevier / Scopus is our data provider.

Best Regards,
SCImago Team

T **Tarik** 3 years ago

Dear. Elena
Hi

Please can we concedar AIP conference proceeding as journal .What i mean ,the publication type could be
journal of AIP conference proceedings .

Best regards

TArik AlOmran

reply

SCImago Team

**Elena Corera** 3 years ago

Dear Tarik,

thank you very much for your comment. Unfortunately, we cannot help you with your request, we suggest you contact journal's editorial staff so they could inform you more deeply. You can find contact information in SJR website https://www.scimagojr.com

D **Dunia** 3 years ago

dear
did the AIP conference (TMREES 18)have Thomson roeters or scopus or SJR Rank or not?

reply

SCImago Team

**Elena Corera** 3 years ago

Dear Dunia,

thank you very much for your comment. SCImago Journal & Country Ranks shows all the journal's vailable information in Open Access If you do not locate the journal in the search engine, Scopus / Elsevier has not provided us those data.

Best Regards,
SCImago Tea

B **Budi Adiperdana** 3 years ago

Dear Admin,

Could you please add the Quartile Rank for AIP Conference Proceedings

Best regards,
Budi

reply

SCImago Team

**Elena Corera** 3 years ago

Dear Budi, for Conferences and Proceedings the SJR is not calculated. Best Regards, SCImago Team

**Leave a comment**

Name

Email
(will not be published)

The users of Scimago Journal & Country Rank have the possibility to dialogue through comments linked to a specific journal. The purpose is to have a forum in which general doubts about the processes of publication in the journal, experiences and other issues derived from the publication of papers are resolved. For topics on particular articles, maintain the dialogue through the usual channels with your editor.

## For Organizers

Abstracting & Indexing

FAQ for Organizers

Peer Review

The Publication Process

Testimonials from Editors & Organizers

# Abstracting and Indexing (A+I)

AIP Publishing recognizes the importance of enhancing visibility and discoverability of published research by including published research in abstracting and indexing (A+I) databases that researchers use. We support the work of A+I services by providing researchers with access to all of our published proceedings volumes upon publication. However, how quickly selected proceedings are available in an A+I service is up to the provider; AIP Publishing has no influence on this timeframe. AIP Conference Proceedings are indexed in a number of services, including these leading databases:

- The Conference Proceedings Citation Index (part of Web of Science)

- Scopus (Elsevier)
- Inspec
- Chemical Abstracts Service (CAS)
- Astrophysics Data System (ADS)

If you believe our proceedings should be indexed in additional databases, including specialist services used by your research community, please send an email to confproc@aip.org.



## Resources

AUTHOR

LIBRARIAN

ADVERTISER

## General Information

ABOUT

CONTACT

HELP

PRIVACY POLICY

TERMS OF USE

FOLLOW AIP PUBLISHING:

# Table of Contents

## PROCEEDINGS OF THE 3RD AUN/SEED-NET REGIONAL CONFERENCE ON ENERGY ENGINEERING AND THE 7TH INTERNATIONAL CONFERENCE ON THERMOFLUIDS (RCENE/THERMOFLUID 2015)

PREV NEXT

Conference date: 19–20 November 2015
Location: Yogyakarta, Indonesia
ISBN: 978-0-7354-1391-7
Editors: , Samsul Kamal, Harwin Saptoadi, , Jayan Sentanuhady, Adhika Widyaparaga, Indro Pranoto, Keiichi Ishihara, Hideaki Ohgaki, Yasuyuki Takata, Jun Tanimoto, Tetsushi Biwa, Zainal Alimuddin b. Zainal Alauddin, Iman Reksowardojo and Chaiwat Nuthong
Volume number: 1737
Published: Jun 3, 2016

DISPLAY : 20 50 100 all

No Access . June 2016

## Preface: Proceedings of the 3rd AUN/SEED-NET Regional Conference on Energy Engineering and the 7th International Conference on Thermofluids (RCEnE/THERMOFLUID 2015)

AIP Conference Proceedings **1737**, 010001 (2016); https://doi.org/10.1063/1.4949278

# AEROSPACE AND AUTOMOTIVE ENGINEERING

No Access . June 2016

## Aerodynamic study on wing and tail small UAV without runways

Maria F. Soetanto, Randy R., Alfan M. R. and Dzaldi

AIP Conference Proceedings **1737**, 020001 (2016); https://doi.org/10.1063/1.4949279

SHOW ABSTRACT

No Access . June 2016

## Effects of injection pressure and injection timing to exhaust gas opacity for a conventional indirect diesel engine

Agus Budiman, Akmal Irfan Majid, Nirmala Adhi Yoga Pambayun, Lilik Chaerul Yuswono and Sukoco

AIP Conference Proceedings **1737**, 020002 (2016); https://doi.org/10.1063/1.4949280

SHOW ABSTRACT

# ENERGY CONVERSION, ENERGY HARVESTING SYSTEMS, AND ENERGY MANAGEMENT

No Access . June 2016

## Optical arc sensor using energy harvesting power source

Kyoo Nam Choi and Hee Hyuk Rho

AIP Conference Proceedings **1737**, 030001 (2016); https://doi.org/10.1063/1.4949281

SHOW ABSTRACT

No Access . June 2016

## Simulation model of stratified thermal energy storage tank using finite difference method

Joko Waluyo

AIP Conference Proceedings **1737**, 030002 (2016); https://doi.org/10.1063/1.4949282

SHOW ABSTRACT

No Access . June 2016

## The development and testing of a novel cross axis wind turbine

W. T. Chong, W. K. Muzammil, M. Gwani, K. H. Wong, A. Fazlizan, C. T. Wang and S. C. Poh

AIP Conference Proceedings **1737**, 030003 (2016); https://doi.org/10.1063/1.4949283

BROWSE VOLUMES

SHOW ABSTRACT

No Access . June 2016

## A ground reaction force analysis for designing a sustainable energy-harvesting stairway

Debrina Puspitarini, Amalia Suzianti, Harun Al Rasyid and Nabila Priscandy

AIP Conference Proceedings **1737**, 030004 (2016); https://doi.org/10.1063/1.4949284

SHOW ABSTRACT

No Access . June 2016

## Cooling performance and evaluation of automotive refrigeration system for a passenger car

Prajitno, Deendarlianto, Akmal Irfan Majid, Mahardeka Dhias Mardani, Wendi Wicaksono, Samsul Kamal, Teguh Pudji Purwanto and Fauzun

AIP Conference Proceedings **1737**, 030005 (2016); https://doi.org/10.1063/1.4949285

SHOW ABSTRACT

No Access . June 2016

## Combustion of char from plastic wastes pyrolysis

Harwin Saptoadi, Tri Agung Rohmat and Sutoyo

AIP Conference Proceedings **1737**, 030006 (2016); https://doi.org/10.1063/1.4949286

SHOW ABSTRACT

No Access . June 2016

## Production of carbon nanotubes: Chemical vapor deposition synthesis from liquefied petroleum gas over Fe-Co-Mo tri-metallic catalyst supported on MgO

P. Setyopratomo, Praswasti P. D. K. Wulan and M. Sudibandriyo

AIP Conference Proceedings **1737**, 030007 (2016); https://doi.org/10.1063/1.4949287

SHOW ABSTRACT

No Access . June 2016

## High fuel price: Will Indonesian shift to public transportation?

Bertha Maya Sopha and Adhiguna Ramadhani Pamungkas

AIP Conference Proceedings **1737**, 030008 (2016); https://doi.org/10.1063/1.4949288

SHOW ABSTRACT

# MULTIPHASE FLOW, FLUID DYNAMICS, AND FLUID STRUCTURE INTERACTION

No Access . June 2016

## Development of two-phase pipeline hydraulic analysis model based on Beggs-Brill correlation

BROWSE VOLUMES

Joko Waluyo, Achilleus Hermawan and Indarto

AIP Conference Proceedings **1737**, 040001 (2016); https://doi.org/10.1063/1.4949289

SHOW ABSTRACT

No Access . June 2016

## An adaptive mesh finite volume method for the Euler equations of gas dynamics

Sudi Mungkasi

AIP Conference Proceedings **1737**, 040002 (2016); https://doi.org/10.1063/1.4949290

SHOW ABSTRACT

No Access . June 2016

## Experimental study on the effect of surface temperature and Weber number to spreading ratio of multiple droplets on a horizontal surface

Ardi Wiranata, Indro Pranoto, Windy H. Mitrakusuma, Deendarlianto and Samsul Kamal

AIP Conference Proceedings **1737**, 040003 (2016); https://doi.org/10.1063/1.4949291

SHOW ABSTRACT

No Access . June 2016

BROWSE VOLUMES

## The effect of plasma actuator on the depreciation of the aerodynamic drag on box model

Harinaldi, Budiarso, James Julian and Rabbani M. N.

AIP Conference Proceedings **1737**, 040004 (2016); https://doi.org/10.1063/1.4949292

SHOW ABSTRACT

No Access . June 2016

## Kerosene-water separation in T-junction with orientation upward branch with a 60° angle: Variation of diameter ratio

Dewi Puspitasari, Indarto, Purnomo and Khasani

AIP Conference Proceedings **1737**, 040005 (2016); https://doi.org/10.1063/1.4949293

SHOW ABSTRACT

No Access . June 2016

## Investigating the influences of two position (non-staggered and staggered) of wind turbine arrays to produce power in a wind farm

Ismail, Samsul Kamal, Purnomo and Sarjiya

AIP Conference Proceedings **1737**, 040006 (2016); https://doi.org/10.1063/1.4949294

SHOW ABSTRACT

No Access . June 2016

## Effect of superficial velocity on vaporization pressure drop with propane in horizontal circular tube

S. Novianto, A. S. Pamitran, Nasruddin and M. I. Alhamid

AIP Conference Proceedings **1737**, 040007 (2016); https://doi.org/10.1063/1.4949295

SHOW ABSTRACT

No Access . June 2016

## Particle-bubble aggregate stability on static bubble generated by single nozzle on flotation process

Warjito, Harinaldi, Manus Setyantono and Sahala D. Siregar

AIP Conference Proceedings **1737**, 040008 (2016); https://doi.org/10.1063/1.4949296

SHOW ABSTRACT

No Access . June 2016

## Experimental investigation on liquid film asymmetry in air-water horizontal annular flow

Andriyanto Setyawan, Deendarlianto, Indarto and Fredrick Neo

AIP Conference Proceedings **1737**, 040009 (2016); https://doi.org/10.1063/1.4949297

SHOW ABSTRACT

No Access . June 2016

## An improved algorithm of image processing technique for film thickness measurement in a horizontal stratified gas-liquid two-phase flow

Hadiyan Yusuf Kuntoro, Akhmad Zidni Hudaya, Okto Dinaryanto, Akmal Irfan Majid and Deendarlianto

AIP Conference Proceedings **1737**, 040010 (2016); https://doi.org/10.1063/1.4949298

SHOW ABSTRACT

No Access . June 2016

## Image processing analysis on the air-water slug two-phase flow in a horizontal pipe

Okto Dinaryanto, Arif Widyatama, Akmal Irfan Majid, Deendarlianto and Indarto

AIP Conference Proceedings **1737**, 040011 (2016); https://doi.org/10.1063/1.4949299

SHOW ABSTRACT

No Access . June 2016

## Experimental investigation on the interfacial characteristics of stratified air-water two-phase flow in a horizontal pipe

Akhmad Zidni Hudaya, Hadiyan Yusuf Kuntoro, Okto Dinaryanto, Deendarlianto and Indarto

AIP Conference Proceedings **1737**, 040012 (2016); https://doi.org/10.1063/1.4949300

SHOW ABSTRACT

No Access . June 2016

## Development of liquid-liquid cylindrical cyclone (LLCC) separator for oil-water separation

Irfan Aditya Dharma, Fuad Arffan, Anggi Riyo Prambudi, Adhika Widyaparaga, Indro Pranoto and Khasani

AIP Conference Proceedings **1737**, 040013 (2016); https://doi.org/10.1063/1.4949301

SHOW ABSTRACT

No Access . June 2016

## Experimental study on the void fraction of air-water two-phase flow in a horizontal circular minichannel

Sudarja, Indarto, Deendarlianto and Aqli Haq

AIP Conference Proceedings **1737**, 040014 (2016); https://doi.org/10.1063/1.4949302

SHOW ABSTRACT

No Access . June 2016

## Characteristics of the air-water counter current two-phase flow in a 1/30 scale of pressurized water reactor (PWR): Interfacial behavior and CCFL data

Apip Badarudin, Indarto, Deendarlianto and Andriyanto Setyawan

AIP Conference Proceedings **1737**, 040015 (2016); https://doi.org/10.1063/1.4949303

SHOW ABSTRACT

# PHASE CHANGE AND HEAT AND MASS TRANSFER

No Access . June 2016

## Fouling resistance prediction using artificial neural network nonlinear auto-regressive with exogenous input model based on operating conditions and fluid properties correlations

Totok R. Biyanto

AIP Conference Proceedings **1737**, 050001 (2016); https://doi.org/10.1063/1.4949304

SHOW ABSTRACT

No Access . June 2016

## Experimental investigation on the phenomena around the onset nucleate boiling during the impacting of a droplet on the hot surface

Windy H. Mitrakusuma, Deendarlianto, Samsul Kamal, Indarto and M. Nuriyadi

AIP Conference Proceedings **1737**, 050002 (2016); https://doi.org/10.1063/1.4949305

SHOW ABSTRACT

No Access . June 2016

## Numerical study of effect parameter fluid flow nanofluid $Al_2O_3$-water on heat transfer in corrugated tube

Anwar Ilmar Ramadhan, Ery Diniardi and Erwin Dermawan

BROWSE VOLUMES

SHOW ABSTRACT

No Access . June 2016

## Thermal performance of evacuated tube heat pipe solar collector

Nandy Putra, M. R. Kristian, R. David, K. Haliansyah and Bambang Ariantara

AIP Conference Proceedings **1737**, 050004 (2016); https://doi.org/10.1063/1.4949307

SHOW ABSTRACT

# RENEWABLE ENERGY AND BIOFUELS

No Access . June 2016

## Wave energy resource assessment based on satellite observations around Indonesia

Agustinus Ribal and Stefan Zieger

AIP Conference Proceedings **1737**, 060001 (2016); https://doi.org/10.1063/1.4949308

SHOW ABSTRACT

No Access . June 2016

## Experimental study of heat transfer enhancement in solar air

Tri Istanto, Dominicus Danardono, Indri Yaningsih and Agung Tri Wijayanta

AIP Conference Proceedings **1737**, 060002 (2016); https://doi.org/10.1063/1.4949309

SHOW ABSTRACT

No Access . June 2016

## Effect of fermentation conditions on biohydrogen production from cassava starch by anaerobic mixed cultures

Hai M. Tien, Kien A. Le, An T. Tran and Phung K. Le

AIP Conference Proceedings **1737**, 060003 (2016); https://doi.org/10.1063/1.4949310

SHOW ABSTRACT

No Access . June 2016

## Extraction fatty acid as a source to produce biofuel in microalgae *Chlorella* sp. and *Spirulina* sp. using supercritical carbon dioxide

Do Chiem Tai, Dam Thi Thanh Hai, Nguyen Hanh Vinh and Le Thi Kim Phung

AIP Conference Proceedings **1737**, 060004 (2016); https://doi.org/10.1063/1.4949311

SHOW ABSTRACT

No Access . June 2016

BROWSE VOLUMES

## Effect of cooled EGR on performance and exhaust gas emissions in EFI spark ignition engine fueled by gasoline and wet methanol blends

Heru Rohadi, Syaiful and Myung-Whan Bae

AIP Conference Proceedings **1737**, 060005 (2016); https://doi.org/10.1063/1.4949312

SHOW ABSTRACT

No Access . June 2016

## Effective conversion of biomass tar into fuel gases in a microwave reactor

Samsudin Anis and Z. A. Zainal

AIP Conference Proceedings **1737**, 060006 (2016); https://doi.org/10.1063/1.4949313

SHOW ABSTRACT

No Access . June 2016

## Zoning of the territory of Russia by the effectiveness of low-potential heat of the ground and atmospheric air for heating buildings

G. P. Vasilyev, M. V. Kolesova, V. F. Gornov and I. A. Yurchenko

AIP Conference Proceedings **1737**, 060007 (2016); https://doi.org/10.1063/1.4949314

SHOW ABSTRACT

No Access . June 2016

## Catalytic cracking of the top phase fraction of bio-oil into upgraded liquid oil

Sunarno, Rochmadi, Panut Mulyono and Arief Budiman

AIP Conference Proceedings **1737**, 060008 (2016); https://doi.org/10.1063/1.4949315

SHOW ABSTRACT

No Access . June 2016

## Catalytic decomposition of tar derived from wood waste pyrolysis using Indonesian low grade iron ore as catalyst

Doni Rahmat Wicakso, Sutijan, Rochmadi and Arief Budiman

AIP Conference Proceedings **1737**, 060009 (2016); https://doi.org/10.1063/1.4949316

SHOW ABSTRACT

No Access . June 2016

## Quality evaluation of onion bulbs during low temperature drying

M. Djaeni, N. Asiah, Y. P. Wibowo and D. A. A. Yusron

AIP Conference Proceedings **1737**, 060010 (2016); https://doi.org/10.1063/1.4949317

SHOW ABSTRACT

No Access . June 2016

## The development of the super-biodiesel production continuously from Sunan pecan oil through the process of reactive distillation

Eflita Yohana, Moh. Endy Yulianto, Diyono Ikhsan, Aditya Marga Nanta and Ristiyanti Puspitasari

AIP Conference Proceedings **1737**, 060011 (2016); https://doi.org/10.1063/1.4949318

SHOW ABSTRACT

No Access . June 2016

## Catalytic and electrochemical behaviour of solid oxide fuel cell operated with simulated-biogas mixtures

T. Dang-Long, T. Quang-Tuyen and Y. Shiratori

AIP Conference Proceedings **1737**, 060012 (2016); https://doi.org/10.1063/1.4949319

SHOW ABSTRACT

No Access . June 2016

## The optimization process of biodiesel production using multiple feedstock (CPO and Jatropha) with assistance of ultrasound at 40 kHz

Berkah Fajar, Wilis and Widayat

AIP Conference Proceedings **1737**, 060013 (2016); https://doi.org/10.1063/1.4949320

SHOW ABSTRACT

No Access . June 2016

## The effect of stirring in the hydrothermal process to convert the mixed municipal solid waste into uniform solid fuel

P. Prawisudha, G. F. Mu'min, K. Yoshikawa and A. D. Pasek

AIP Conference Proceedings **1737**, 060014 (2016); https://doi.org/10.1063/1.4949321

SHOW ABSTRACT

No Access . June 2016

## Hydrothermal liquefaction of palm oil empty fruit bunch (EFB) into bio-oil in different organic solvents

Rakhman Sarwono, Eka Dian Pusfitasari and Muhammad Ghozali

AIP Conference Proceedings **1737**, 060015 (2016); https://doi.org/10.1063/1.4949322

SHOW ABSTRACT

No Access . June 2016

## The performance & flow visualization studies of three-dimensional (3-D) wind turbine blade models

Sutrisno, Prajitno, Purnomo and Setyawan B. W.

AIP Conference Proceedings **1737**, 060016 (2016); https://doi.org/10.1063/1.4949323

SHOW ABSTRACT