Document details

Materials Science Forum
Volume 981 MSF, 2020, Pages 84-91
Postgraduate Symposium on Industrial Science and Technology, SISTEC 2019; Kuantan; Malaysia; 22 August 2019 through 23 August 2019; Code 238589

Substrate placement inside CVD tube for graphene production (Book Chapter)

Osman, M.N.[a], Ani, M.H.[b], Bakar, S.N.S.A.[a]

[a]Department of Mechanical Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia
[b]Department of Manufacturing and Materials Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia

Abstract

View references (23)

Electronics and energy storage industry demand production of high-quality graphene which currently still a challenge. Chemical vapor deposition (CVD) has shown promises for high- quality graphene production. However, it involves control of many parameters from different aspects such as thermal-fluid, mass transport, and chemical reaction. Thermal fluid aspect plays a significant role in CVD production of graphene but yet to be explored extensively. For a tubular hot-wall CVD with the heating reactor, issue of flow instability that will prolong the existence of vortices and spiral flow until the substrate required attention. Therefore current study aims to find the optimum substrate position inside the furnace. For that purpose the gas flow streamline will be observed, and minimum axial distance of the substrate will be determined. The tubular CVD is modeled using ANSYS Fluent®. The current model will not consider the chemical reaction involves and only single gas is used. This should be enough to seek the influence of thermal-fluid aspects involves in CVD. The CVD tube will be divided into 3 sections where the middle part (furnace) was heated up to 1273K and the other two sections were kept at 300K. Gas was supplied to the tube and the distance from the furnace inlet to the point where the flow is fully developed is measured. Streamlines for the flow is also observed. The streamline shows that there is an induced secondary flow starting at the inlet which lasted until a certain axial distance. For flow with 50 sccm of flowrate needs an axial distance of 5 cm while flow with 250 sccm of flowrate needs 7 cm in order to become a smooth flow. Our results show that the placement of the substrate in the tubular hot- wall CVD required attention in CVD design. For flow with higher flowrate, it requires longer distance for the flow to become smooth and laminar and vice versa. © 2020 Trans Tech Publications Ltd, Switzerland.

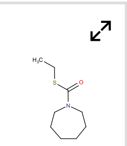
SciVal Topic Prominence

Topic: Vapor Deposition | Graphite | Low Energy Electron Diffraction

Prominence percentile: 99.634

Chemistry database information

Substances



Author keywords

APCVD | CFD | Fluid dynamics | Graphene | Heat transfer

Related documents

The role of gas-phase dynamics in interfacial phenomena during few-layer graphene growth through atmospheric pressure chemical vapour deposition
Fauzi, F.B. , Ismail, E. , Syed Abu Bakar, S.N.
(2020) Physical Chemistry Chemical Physics

Main effects analysis of graphene grown by chemical vapor deposition using orthogonal arrays | Ortogonal dizinler kullanarak kimyasal buhar çöktürme yöntemi ile büyütülen grafenin ana etkiler analizi
Şimşek, B. , Dilmac, Ö.F.
(2018) Journal of the Faculty of Engineering and Architecture of Gazi University

TOPSIS based Taguchi design optimization for CVD growth of graphene using different carbon sources: Graphene thickness, defectiveness and homogeneity
Şimşek, B.
(2019) Chinese Journal of Chemical Engineering

View all related documents based on references

Find more related documents in Scopus based on:

Indexed keywords

Engineering controlled terms: Chemical reactions; Chemical vapor deposition; Electronics industry; Flow of gases; Furnaces; Graphene; Transport properties

Engineering uncontrolled terms: Axial distance; Chemical vapor depositions (CVD); Current modeling; Flow instabilities; Flow streamlines; High quality; Substrate positions; Thermal fluids

Engineering main heading: Substrates

Funding details

Funding sponsor	Funding number	Acronym
International Islamic University Malaysia		IIUM
International Islamic University Malaysia		IIUM

Funding text

This work was financially supported Research Initiative Grant Scheme (RIGS17-054-0629) and International Islamic University Malaysia (IIUM).

ISSN: 02555476
ISBN: 978-303571664-1
CODEN: MSFOE
Source Type: Book Series
Original language: English

DOI: 10.4028/www.scientific.net/MSF.981.84
Document Type: Book Chapter
Volume Editors: Sutjipto A.G.E.,Zulkifli F.H.,Misnon I.I.
Publisher: Trans Tech Publications Ltd

References (23)

View in search results format >

All | Export | Print | E-mail | Save to PDF | Create bibliography

1 Li, G., Huang, S.-H., Li, Z.
Gas-phase dynamics in graphene growth by chemical vapour deposition
(2015) *Physical Chemistry Chemical Physics*, 17 (35), pp. 22832-22836. Cited 17 times.
http://pubs.rsc.org/en/journals/journal/cp
doi: 10.1039/c5cp02301g
View at Publisher

2 Li, Z.
(2012) *Graphene thickness control via gas-phase dynamics in chemical vapor deposition*

3 Chen, C.Y., Dai, D., Chen, G.X., Yu, J.H., Nishimura, K., Lin, C.-T., Jiang, N., (...), Zhan, Z.L.
Rapid growth of single-layer graphene on the insulating substrates by thermal CVD
(2015) *Applied Surface Science*, 346, pp. 41-45. Cited 31 times.
http://www.journals.elsevier.com/applied-surface-science/
doi: 10.1016/j.apsusc.2015.03.204
View at Publisher

☐ 4 Novoselov, K.S., Geim, A.K., Morozov, S.V., Jiang, D., Zhang, Y., Dubonos, S.V., Grigorieva, I.V., (...), Firsov, A.A.

Electric field in atomically thin carbon films

(2004) *Science*, 306 (5696), pp. 666-669. Cited 41340 times.
doi: 10.1126/science.1102896

View at Publisher

☐ 5 Yu, K., Hayman, C.C., Manjunath, S., Fan, W., Martin, I.T., Martin, H.B., Sankaran, R.M.

A combined CFD modeling and experimental study of pyrolytic carbon deposition

(2016) *Diamond and Related Materials*, 70, pp. 173-178. Cited 2 times.
doi: 10.1016/j.diamond.2016.10.010

View at Publisher

☐ 6 Bhaviripudi, S., Jia, X., Dresselhaus, M.S., Kong, J.

Role of kinetic factors in chemical vapor deposition synthesis of uniform large area graphene using copper catalyst

(2010) *Nano Letters*, 10 (10), pp. 4128-4133. Cited 593 times.
doi: 10.1021/nl102355e

View at Publisher

☐ 7 Muñoz, R., Gómez-Aleixandre, C.

Review of CVD synthesis of graphene

(2013) *Chemical Vapor Deposition*, 19 (10-12), pp. 297-322. Cited 222 times.
doi: 10.1002/cvde.201300051

View at Publisher

☐ 8 Huang, P.Y., Ruiz-Vargas, C.S., Van Der Zande, A.M., Whitney, W.S., Levendorf, M.P., Kevek, J.W., Garg, S., (...), Muller, D.A.

Grains and grain boundaries in single-layer graphene atomic patchwork quilts

(2011) *Nature*, 469 (7330), pp. 389-392. Cited 1365 times.
doi: 10.1038/nature09718

View at Publisher

☐ 9 Pollard, A.J.
(2014) *Quantitative characterization of defect size in graphene using Raman spectroscopy Quantitative characterization of defect size in graphene using Raman spectroscopy*
253107

☐ 10 Kleijn, C.R., Dorsman, R., Kuijlaars, K.J., Okkerse, M., van Santen, H.

Multi-scale modeling of chemical vapor deposition processes for thin film technology

(2007) *Journal of Crystal Growth*, 303 (1 SPEC. ISS.), pp. 362-380. Cited 52 times.
http://www.journals.elsevier.com/journal-of-crystal-growth/
doi: 10.1016/j.jcrysgro.2006.12.062

View at Publisher

☐ 11 Deng, B., Liu, Z., Peng, H.
(2018) *Toward mass production of CVD graphene films*, pp. 1-25.
1800996

☐ 12 Aydin, O.I., Hallam, T., Thomassin, J.L., Mouis, M., Duesberg, G.S.

Interface and strain effects on the fabrication of suspended CVD graphene devices

(2015) *Solid-State Electronics*, 108, pp. 75-83. Cited 10 times.
http://www.elsevier.com/wps/find/journaldescription.cws_home/103/description#description
doi: 10.1016/j.sse.2014.12.003

View at Publisher

☐ 13 Tetlow, H., Posthuma de Boer, J., Ford, I.J., Vvedensky, D.D., Coraux, J., Kantorovich, L.

Growth of epitaxial graphene: Theory and experiment

(2014) *Physics Reports*, 542 (3), pp. 195-295. Cited 150 times.
http://www.elsevier.com/locate/physrep
doi: 10.1016/j.physrep.2014.03.003

View at Publisher

☐ 14 Li, X., Wang, H., Robinson, J.T., Sanchez, H., Diankov, G., Dai, H.

Simultaneous nitrogen doping and reduction of graphene oxide

(2009) *Journal of the American Chemical Society*, 131 (43), pp. 15939-15944. Cited 1343 times.
http://pubs.acs.org/doi/pdfplus/10.1021/ja907098f
doi: 10.1021/ja907098f

View at Publisher

☐ 15 Chen, X., Zhang, L., Chen, S.

Large area CVD growth of graphene

(2015) *Synthetic Metals*, Part A 210, pp. 95-108. Cited 95 times.
http://www.journals.elsevier.com/synthetic-metals/
doi: 10.1016/j.synthmet.2015.07.005

View at Publisher

☐ 16 Deokar, G., Avila, J., Razado-Colambo, I., Codron, J.-L., Boyaval, C., Galopin, E., Asensio, M.-C., (...), Vignaud, D.

Towards high quality CVD graphene growth and transfer

(2015) *Carbon*, 89, pp. 82-92. Cited 100 times.
http://www.journals.elsevier.com/carbon/
doi: 10.1016/j.carbon.2015.03.017

View at Publisher

☐ 17 Novoselov, K.S., Castro Neto, A.H.
(2012) *Two-dimensional crystals-based heterostructures: Materials with tailored properties*

☐ 18 Pham, T.T., Huynh, T.H., Do, Q.H., Ngo, T.K.V.

Optimum reproduction and characterization of graphene on copper foils by low pressure chemical vapor deposition

(2019) *Materials Chemistry and Physics*, 224, pp. 286-292. Cited 2 times.
http://www.journals.elsevier.com/materials-chemistry-and-physics
doi: 10.1016/j.matchemphys.2018.12.009

View at Publisher

19 An, L.S., Yang, Z., Zhong, G.Y., Liu, Y.W.
Improvement of Heat and Mass Transfer Performance in a Polysilicon Chemical Vapor Deposition Reactor with Field Synergy Principle (Open Access)

(2017) *Energy Procedia*, 105, pp. 688-693. Cited 3 times.
http://www.sciencedirect.com/science/journal/18766102
doi: 10.1016/j.egypro.2017.03.376

View at Publisher

20 Chinoy, P.B., Kaminski, D.A., Ghandhi, S.K.
Effects of thermal radiation on momentum, heat, and mass transfer in a horizontal chemical vapor deposition reactor

(1991) *Numerical Heat Transfer; Part A: Applications*, 19 (1), pp. 85-100. Cited 16 times.
doi: 10.1080/10407789108944839

View at Publisher

21 Endo, H., Kuwana, K., Saito, K., Qian, D., Andrews, R., Grulke, E.A.
CFD prediction of carbon nanotube production rate in a CVD reactor

(2004) *Chemical Physics Letters*, 387 (4-6), pp. 307-311. Cited 70 times.
doi: 10.1016/j.cplett.2004.01.124

View at Publisher

22 Szekely, J., Ilegbusi, O.J.
On three-dimensional transport phenomena in cvd processes

(1987) *Journal of the Electrochemical Society*, 134 (10), pp. 2552-2559. Cited 44 times.
doi: 10.1149/1.2100242

View at Publisher

23 Fauzi, F.B., Ismail, E., Osman, M.N., Rosli, M.S., Ismail, A.F., Mohamed, M.A., Bakar, S.N.S.A., (...), Ani, M.H.
Influence of mixed convection in atmospheric pressure chemical vapor deposition of graphene growth

(2019) *Materials Today: Proceedings*, Part 2 7, pp. 638-645. Cited 3 times.
http://www.journals.elsevier.com/materials-today-proceedings/
doi: 10.1016/j.matpr.2018.12.055

View at Publisher

Bakar, S.N.S.A.; Department of Mechanical Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, Malaysia; email:syednoh@iium.edu.my