

High-speed synthesis of fullerenes by using low-frequency induction thermal plasma with pulse-modulated mode.

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| メタデータ | 言語: jpn 出版者: 公開日: 2021-08-26 キーワード (Ja): キーワード (En): 作成者: メールアドレス: 所属: |
| URL | https://doi.org/10.24517/00063543 |

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2001 Fiscal Year Final Research Report Summary

High-speed synthesis of fullerenes by using low-frequency induction thermal plasma with pulse-modulated mode.

Research Project

Project/Area Number

11555078

Research Category

Grant-in-Aid for Scientific Research (B)

Allocation Type

Single-year Grants

Section

展開研究

Research Field

電力工学・電気機器工学

Research Institution

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Project Period (FY)

1999 – 2001

Keywords

Nano-material / Induction thermal plasma / pulse modulation / Cooling effect / Spectroscopic measurement / Cluster

Research Abstract

(1) Synthesis of fullerenes using high-power induction thermal plasma and dependence of various parameters on the products. Fullerene synthesis were made using high-power induction thermal plasma and dependence of various parameters on the products was investigated. The parameters are as follows: (a) gas kind, (b) pressure, c input power, (d) power materials, (e) location for collection of the products. Through the investigation, the following conditions were found to be preferable for fullerene

synthesis: (a) He as main ambient gas rather than Ar, (b) Lower pressure of 20kPa than 50 or 67 kPa, c Lower input power of 30kW than 50 or 70kW, (d) C+Si material power compared with C+Fe, C+Ni-Co and pure C, (e) long-distance location of 900mm from plasma torch rather than close location. Further investigation was made by numerical simulation of flow and temperature fields in a reaction chamber. This result indicates that use of He increases temperature gradient on the torch axis, which means the high cooling efficiency of gas. Also, it was found that low pressure increases axial flow velocity, which causes high cooling efficiency of gas.

(2) Development of pulse-modulated induction thermal plasma torch and investigation of dynamic response of thermal plasma. A novel system was developed to sustain pulse-modulated induction thermal plasma with amplitude-modulated coil-current. This system has a MOSFET inverter power supply rated at a power of 50kW and a operating frequency of 450kHz. Dynamic response characteristics were investigated for Ar based induction thermal plasma with additional gases. This result indicates that CO₂ inclusion markedly lowers both operating region and dynamic response of pulse-modulated induction thermal plasma. This pulse-modulated induction thermal plasma is available for fullerene synthesis by high-speed cooling and heating.

Research Products (21 results)

All Other

All Publications

[Publications] C.Wang, T.Imahori, Y.Tanaka, T.Sakuta, H.Takikawa, H.Matsuo: "Synthesis of fullerenes from carbon powder by using high power induction thermal plasma"Thin Solid Film. 390. 31-36 (2001)

[Publications] C.Wang, T.Imahori, Y.Tanaka, T.Sakuta, H.Takikawa, H.Matsuo: "Synthesis of fullerenes with C-Si mixed particles by using induction thermal plasma"Proc. 15^<th> Int. Symp. on Plasma Chem. ISPC-15. VII. 2817-2822 (2001)

[Publications] M.M.Hossain, Y.Tanaka, T.Sakuta: "Particle concentration of a partially ionized atmospheric pressure argon plasma in two-temperature reaction kinetic approach"Proc. 15^<th> Int. Symp. on Plasma Chem. ISPC-15. III. 1115-1120 (2001)

[Publications] K.C.Paul, M.M.Hossain, Y.Hashimoto, Y.Tanaka, Y.Sakuta: "Responses of a long-coil pulse-modulated induction plasma"IEEE Trans. On Plasma Sci.. 29. 326-334 (2001)

[Publications] M.M.Hossain, K.C.Paul, Y.Tanaka, T.Sakuta, T.Ishigaki: "Prediction of operating region of pulses modulated rf inductively coupled thermal plasma"J. Phys. D : Appl. Phys.. 33. 1843-1853 (2000)

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[Publications] T.Sakuta, Y.Tanaka, K.C.Paul, M.M.Hossain, T.Ishigaki: "Non-equilibrium effects in pulse modulated induction thermal plasma for advanced processing"Trans. MRS-J. 25. 35-38 (2000)

[Publications] Y.Tanaka, T.Sakuta: "Measurement of dynamic response time in pulse modulated thermal plasma"Trans. MRS-J. 25. 293-296 (2000)

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[Publications] K.C.Paul, M.M.Hossain, Y.Hashimoto, Y.Tanaka, T.Sakuta: "Responses of a long-coil pulse-modulated induction plasma"IEEE Trans. On Plasma Sci.. Vol. 29. 326-334 (2001)

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[Publications] T.Sakuta, Y.Tanaka, K.C.Paul, M.M.Hossain, T.Ishigaki: "Non-equilibrium effects in pulse modulated induction thermal plasma for advanced processing"Trans. MRS-I. Vol.25. 35-38 (2000)

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URL: https://kaken.nii.ac.jp/report/KAKENHI-PROJECT-11555078/115550782001kenkyu_seika_hokoku

Published: 2003-09-16