Micropattern Immobilization of Biomolecules onto Dot-arrayed CNTs Functionalized by Ultrafine Atmospheric Pressure Plasma Jet

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Biochip device are analytical devices integrating with biological sensing element. Recently, biochip based on carbon nanotubes (CNTs) has attracted considerable attention due to the nano-scale, excellent physical properties, unique chemical properties, and remarkable biomolecular recognition of CNT [1]. Successful realization of carbon nanotube based biochip sensors requires appropriate control of their surface functionalization and biomolecules immobilization. Plasma technologies, compared to the conventional chemical treatment, have the advantages to functionalize carbon nanotubes such as little damaging effects, low temperature and non-polluting process. However, for patterning surface of CNTs, conventionally low-pressure plasmas driven by RF or microwaves require physical masks that make the process cumbersome, expensive and time consuming. Among the numerous plasma technologies, atmospheric pressure plasma jet (APPJ) are of intense interest due to the advantages of no need vacuum conditions, technically simple and maskless functionalization [2].

In this work, we study micropattern immobilization of biomolecules onto dot-arrayed CNT functionalized by ultrafine APPJ. An ultrafine APPJ with a micro-capillary was utilized to functionalize amino groups onto dot-arrayed CNTs. Additionally, CNTs with a spacing of 50 μm and a dot size of 5 μm were synthesized by a combined thermal-plasma CVD devices, and constructed in dot array form for realizing the development of biochip device. We used biotin-avidin system and antibody-antigen reaction of E. coli to assess the feasibility of biomolecule immobilization onto dot-arrayed CNTs. Fig.1 shows comparison between untreated and treated APPJ obtained from CNT dot-array of 4×50 μm spots performed biomolecules immobilization. The green areas in Fig.1b correspond to fluorescent dye of avidin (FTIC-avidin) connected to biotin and amino functionalized CNT dot-array. The black areas in Fig.1a indicate that fluorescent dye of FTIC-avidin is not connected to amino functionalized CNT dot-array. Biomolecules immobilization is also confirmed by fluorescence intensity line profile across CNT dot-array of 4×50 μm shown in Fig.1d. The possibility of this technique for biochip device applications was demonstrated by successfully functionalized CNT using ultrafine APPJ and selectively immobilized biomolecules onto dot-arrayed CNT.

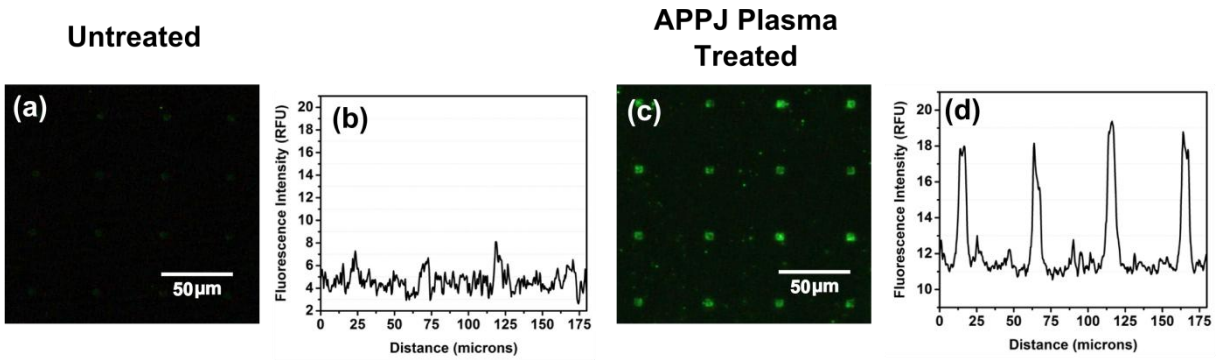

Figure 1. Comparison between untreated and treated APPJ obtained from dot-arrayed CNT performed biomolecules immobilization. (a) and (c): dark field image covered with FITC-Avidin-Biotin; (b) and (d): fluorescence intensity of untreated and treated APPJ, respectively.

References

[1] S. Kruss, A.J. Hilmer, J. Zhang, N.F. Reuel, et al.: Adv. Drug Deliver. Rev. 65 (2013) 1934.
[2] T. Abuzairi, M. Okada, N.R. Poespawati, R.W. Purnamaningsih, M. Nagatsu: Carbon. 89 (2015) 208.