【Grant-in-Aid for Scientific Research (S)】

Integrated Disciplines (Environmental Science)

Title of Project : Development of a Low-energy Flat Plane-emission Panel Device Employing Single-walled Carbon Nanotubes

Kazuyuki Tohji
(Tohoku University, Graduate School of Environmental Studies, Professor)

Research Project Number : 26220104　Researcher Number : 10175474
Research Area : Environmental studies
Keyword : energy efficiency, carbon nanotubes, flat-pane emission

【Purpose and Background of the Research】

After the East Japan great earthquake disaster, we faced big challenges to save and use energy more effectively.

One means of reducing energy demand is to develop new technologies to reduce power consumption in daily life. In this study, we promote the development of a flat plane-emission lighting device employing highly purified and crystallized single-walled carbon nanotubes (SWCNTs) as a field emitter. The flat-plane lighting system is a new device with potential to contribute to low power consumption, and thus to reducing carbon dioxide emission. Furthermore, if we can use SWCNTs throughout the electrical industry, this may contribute towards a low carbon society.

【Research Methods】

We propose to develop a new device employing highly crystallized SWCNT according to the following:

(1) Construction of an electron source device as a field emitter with reduced energy consumption
(2) Construction of a flat-plane lighting device with high brightness efficiency to control ray wavelength, afterglow and phosphorescence.

Specifically for (1), we aim to construct a field electron emission source with a low driving field power below 0.5V/μm using highly purified and crystallized SWCNTs. The electron source will be fabricated with ITO application film dispersing the metallic conductive SWCNTs homogeniously by a wet coating process.

We have succeeded in making a mixture of dispersed SWCNTs by mixing metallic and semiconductor CNTs using a surfactant (Fig.1); this enabled us to fabricate a field emission cathode which showed homogenous lighting emission in a vacuum chamber (Fig. 2).

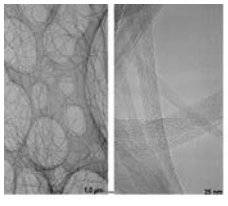

Fig. 1　TEM views of dispersed SWCNTs

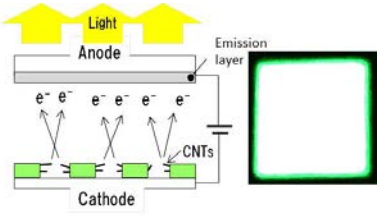

Fig. 2　Structure of cathode and emission homogeneity

In the case of (2), we aim to establish the principle of the flat plane-emission lighting device which can control wavelengths from ultraviolet to near infrared and afterglow characteristics without energy loss in electron-beam excitation.

【Expected Research Achievements and Scientific Significance】

The flat plane-emission panel device controlling phosphorescence characteristic of the lighting layer excited by electron-beam is shown in Fig. 3.

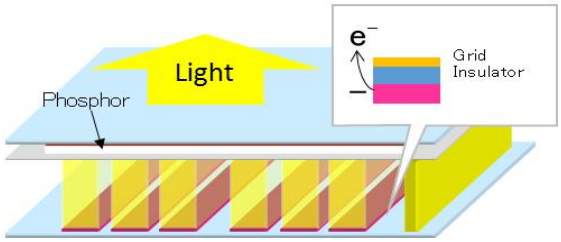

Fig. 3　Structure of a flat-plane-lighting

This lighting device is expected to reduce power consumption to 1/100 of an LED device with controlling an electron beam scan method in a plane. The carbon footprint is thus greatly reduced by our device through saving energy. In addition, the employment of highly crystallized SWCNTs is available to the establishment of assembly technologies for nanocarbon materials in electrical devices.

【Publications Relevant to the Project】

・K. Tohji et al. Nature, 383, 679 (1996).
・S. Iwata et al. J.Phys.Chem. 111, 14937-14941, (2007).
・N. Shimoi et al. Carbon, 65, 223-228(2013).

【Term of Project】 FY2014-2018

【Budget Allocation】 147,800 Thousand Yen

【Homepage Address and Other Contact Information】

http://bucky1.kankyo.tohoku.ac.jp/index.html
tohjik@mail.kankyo.tohoku.ac.jp