Division of Nanocarbon Research

Period: From April 1st, 2018 Through March 31st, 2022

Members of the Division :

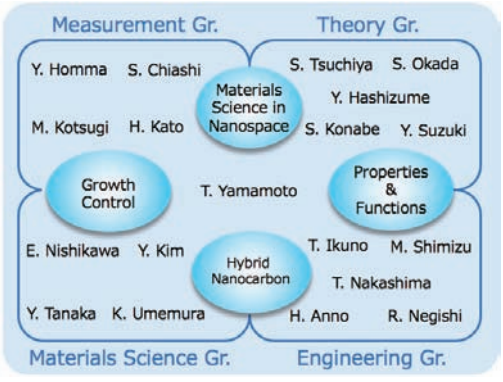
Director:	Associate Professor	Takahiro Yamamoto
Members:	Professor	Yoshikazu Homma
	Professor	Yuichi Negishi
	Professor	Kazuo Umemura
	Professor	Eiichi Nishikawa
	Associate Professor	Yumi Tanaka
	Associate Professor	Takashi Ikuno
	Associate Professor	Masato Kotsugi
	Jr. Associate Professor	Yasumitsu Suzuki
	Jr. Associate Professor	Takashi Nakajima
	Jr. Associate Professor	Yoichiro Hashizume
	Assistant Professor	Maki Shimizu
	Assistant Professor	Yongil Kim
	Visiting Professor	Hiroaki Anno
	Visiting Professor	Susumu Okada
	Visiting Associate Professor	Shunji Tsuchiya
	Visiting Associate Professor	Shohei Chiashi
	Visiting Associate Professor	Satoru Konabe
	Visiting Assistant Professor	Ryota Negishi
	Visiting Researcher	Naomi Hirayama
	Visiting Researcher	Hiroki Kato

Objectives

To investigate novel properties relating to carbon nanotubes and graphene, and to develop material sciences utilizing the nanospace of nanotubes and the interaction between nanotubes and biomolecules.

Research subjects

Carbon nanotubes and graphene are low dimensional Materials (with linear and flat shapes, respectively) composed of networks of 6-members rings (honeycomb structure). Owing to strong covalent bonds of carbon atoms, they have excellent mechanical strength and chemical stability enough to sustain the monolayered structure in a free space. Furthermore, they exhibit properties peculiar to the geometrical configuration and low dimensionality, which cannot be expected for three-dimensional crystals. As you can see from the fact that the Nobel Prize in Physics 2010 relates to graphene, nanocarbons such as carbon nanotubes and graphene are extensively studied in basic science. In the future, nanocarbons are expected to play a main role in an industrial revolution as iron and silicon did in the Industrial Revolution and the information technology revolution, respectively. The Division of Nanocarbon Research covers topics of nanocarbons from fundamental to applied researches by collaboration of experts in theoretical and experimental condensed matter physics, electrical engineering, thermal engineering, and biophysics. We expect synergy effects by enhancing mutual discussion and exchange of ideas in the division.



Future perspective

To promote advanced researches on nanocarbons based on tight and highly active collaborations of division members.

研究成果ハイライト①

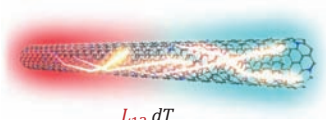
Carbon–Nanotubes based Thermoelectric Materials

Requirements for TE materials

- High thermoelectric power & efficiency
- Ubiquitous elements
- Flexible & toughness

➡ **Nano-carbon Materials**

【Theoretical Modeling】➡【Measurements】➡【Development of Devise】

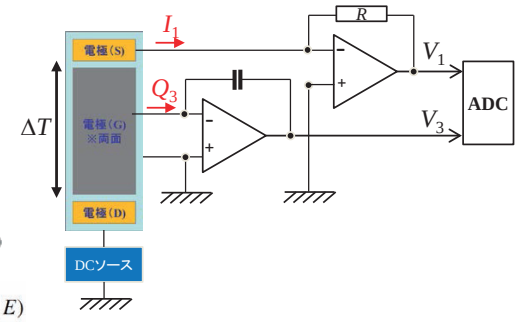


$$J = L_{11}E - \frac{L_{12}}{T}\frac{dT}{dx}$$

$$L_{11} = \int_{-\infty}^{\infty} dE \left(\frac{\partial f(E-\mu)}{\partial E}\right)\alpha(E)$$

$$L_{12} = -\frac{1}{e}\int_{-\infty}^{\infty} dE \left(\frac{\partial f(E-\mu)}{\partial E}\right)(E-\mu)\alpha(E)$$

$$\alpha(E) = \frac{\hbar e^2 v^2}{2\pi V}\sum_k \mathrm{Tr}\left[\sigma_x G^{\mathrm{A}}(k,E)\sigma_x G^{\mathrm{R}}(k,E) - \mathrm{Re}\left\{\sigma_x G^{\mathrm{R}}(k,E)\right\}\right]$$



Succeeded to develop CNT–based TE generation

関連論文：T. Yamamoto & H. Fukuyama, JPSJ **87**, 024707 (2018)　関連特許：特願2017-142754

研究成果ハイライト②

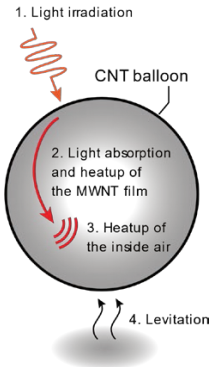
Light–driven Carbon Nanotube Flying Balloons

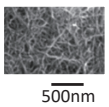
Towards Indoor-type Drones

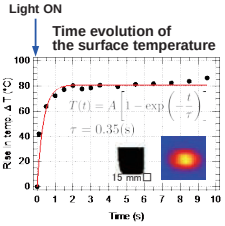
- No wind and no sound
- Wireless power supply and light weight
- Various sensors can be mounted on it

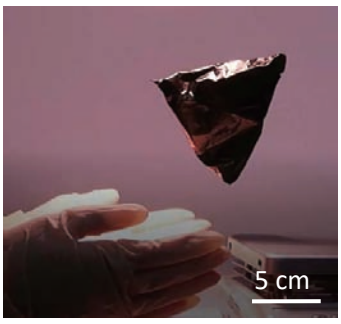
➡ Novel balloons based on **Nanocarbon materials**

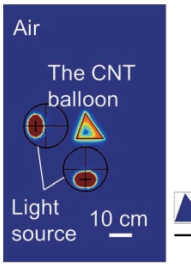
【Design and Materials】➡【Verification】⬅【Simulation】

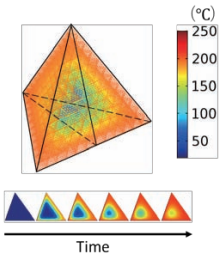












The nanotube balloons were levitated by light irradiation !

関連論文：T. Ikuno *et al.* (submitted), 髙橋，生野ら (submitted).