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Research Activity on Societal Impacts of Nanotechnology in Japan

- Taking Nanocarbon Materials and Devices as Examples -

Masafumi ATA,

Technology Information Department, AIST Tokyo HQs Office,

Ministry of Economy Trade and Industry (METI)

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NATIONAL INSTITUTE OF

ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

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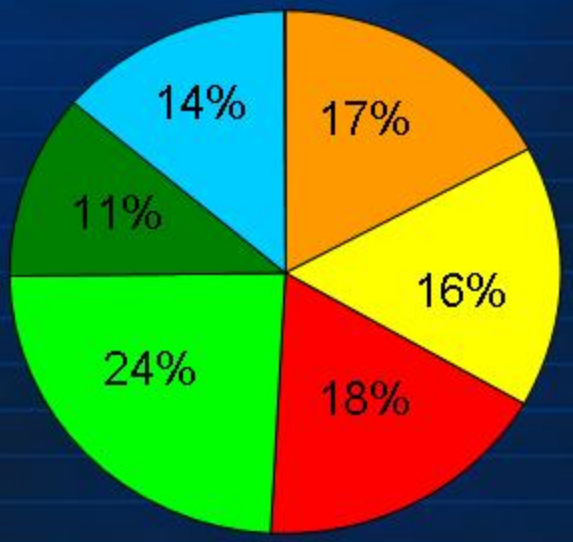
Number of researchers by Research Field



Full-time researcher: 2,152
(April 1, 2004)

- Life Science
- IT
- Nanotechnology Materials and Manufacturing
- Environment & Energy
- Geologic Survey & Geosciences
- Standards & measurement Tech.

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Research Organizations in Nanotechnology Materials & Manufacturing Field in AIST

- Correlated Electron Research Center
- Digital Manufacturing Research Center
- Nanoarchtecctronics Research Center
- Diamond Research Center
- Research Center for Advanced Carbon Materials

- Nanotechnology Research Institute
- Materials Research Institute for Sustainable Development
- Research Institute for Computational Sciences
- Advanced Manufacturing Research Institute

- Micro-Space Chemistry Lab

Center Institute Initiative

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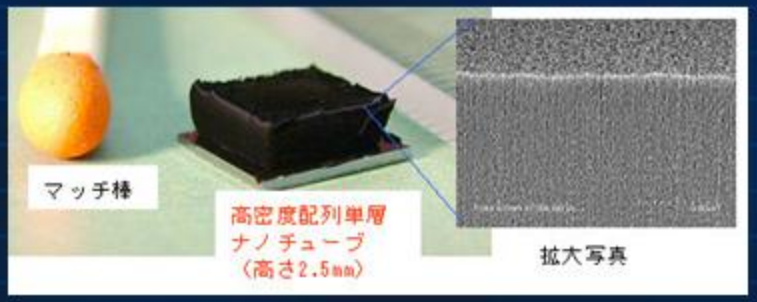
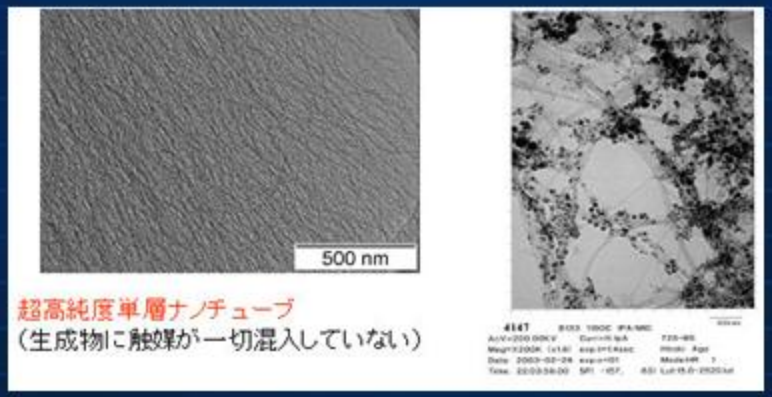
Research Center for Advanced Carbon Materials

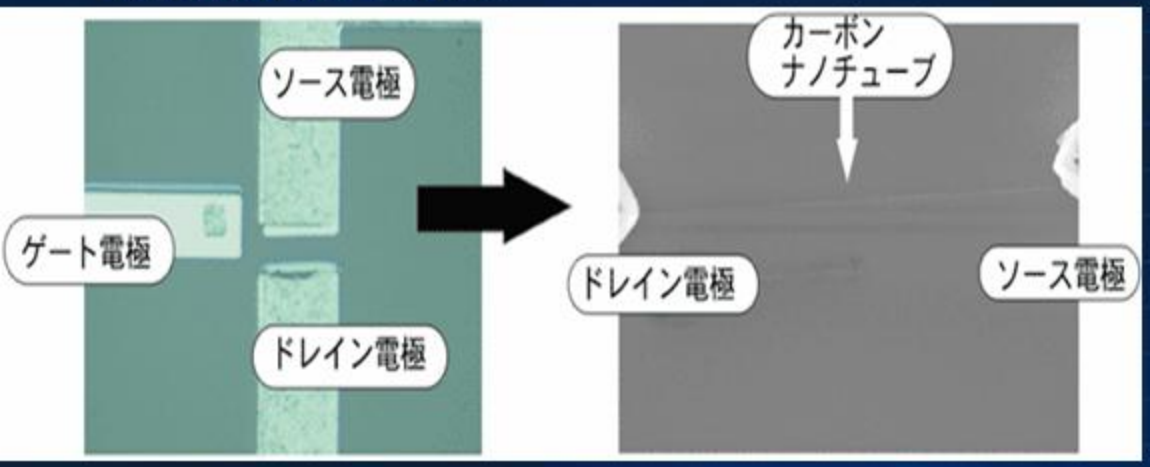


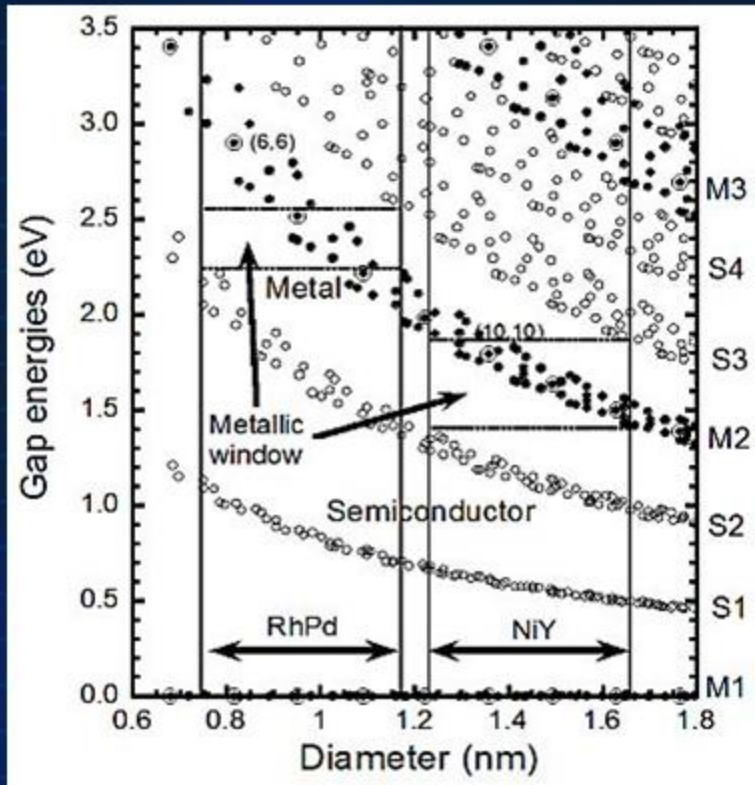


Science, 2004 November 19th Issue
"Water-Assisted Highly Efficient Synthesis of Impurity-Free Single-Walled Carbon Nanotubes" By Hata et al.,

Nanotechnology Research Institute

Quantum Devices





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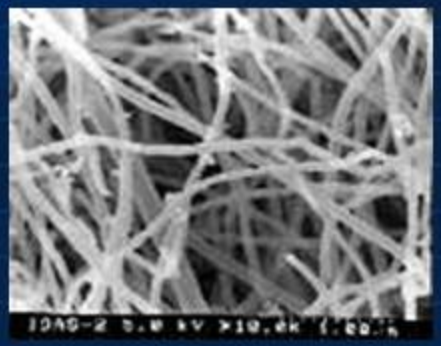
CNT production in Japan

Nikkiso *CVD*
GSI Creos *CVD*
Showa Denko *CVD*
JFE Engineering *Arc*
NEC Adv. Labo. *Arc, CVD*
Mitsubishi Corp. *Arc*
Toray *CVD*
Fujitsu *CVD*
Honjyo Chemical *Arc*
Mitsubishi Heavy Industries *CVD*
Bussan Nanotech Research Institute *CVD*
Osaka Gas *CVD (a-CNT)*
Hitachi Zosen *CVD*
MEFS (Prof. Endo) + Showa Denko *CVD*
Meijyo Nanocarbon (Prof. Ando)



WPC EXPO 2003で展示した
燃料電池内蔵ノートパソコン試作機

筒状の容器は燃料補充用のもの。
補充後は取り外して使います。

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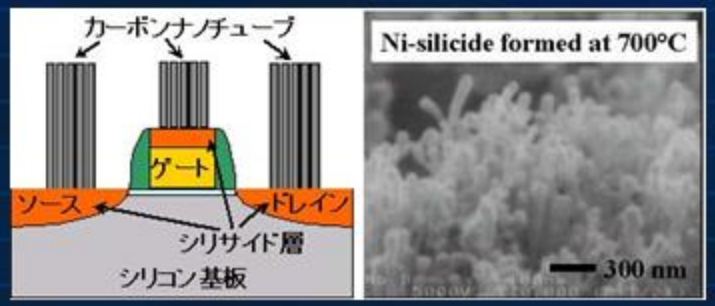
Fujitsu Laboratories
CNT application in Semiconductor Devices



CNT electrode in MOSFET

HANNOVER, Germany--Microprocessors that use carbon nanotubes rather than copper wires to connect layers of transistors may be available in less than a decade, according to Fujitsu Siemens

Y. Awano

Carbon Nanotube Application for Future ULSI

Low-Temperature CNT Growth for ULSI

*High Current Density 10^9 A/cm^2
*Ultra-high Thermal Conductivity
*Ballistic Transport
*Steadiest Bonding sp^2

→ Wirering Material for Future ULSI Interconnect

@ The First International Nanotechnology Conference, 1-3 July 2005, Marriott, SF, CL.

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Fullerene production in Japan

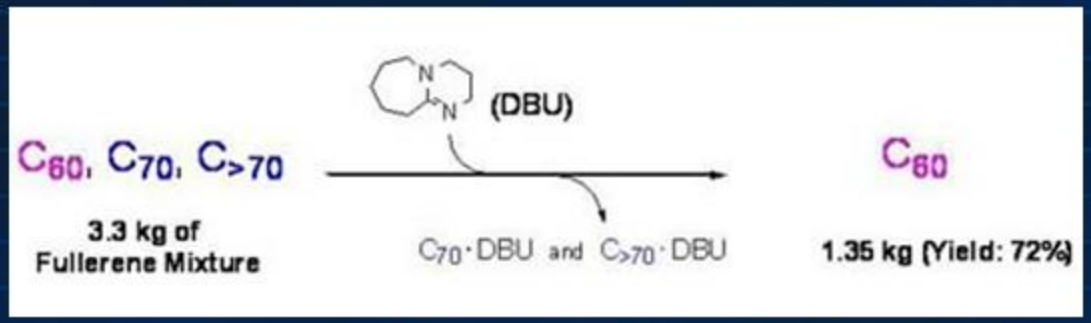
Frontier Carbon (Nanom)

Affiliated company of Mitsubishi Corporation

Production: @ Kurosaki Kita-Kyushu

Method: Combustion of industrial toluene

Capacity of production of fullerenens: 40t / year



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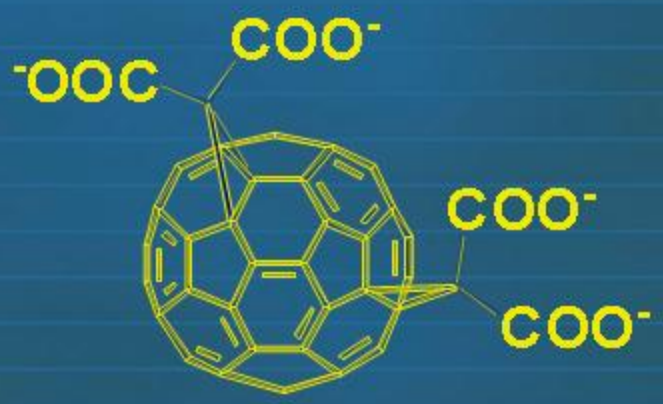
Fullerene Medical Application

Anionic Derivative

Scavenger of Active Oxygens

⇩

Anti-Neurodegenerative Disease Agent

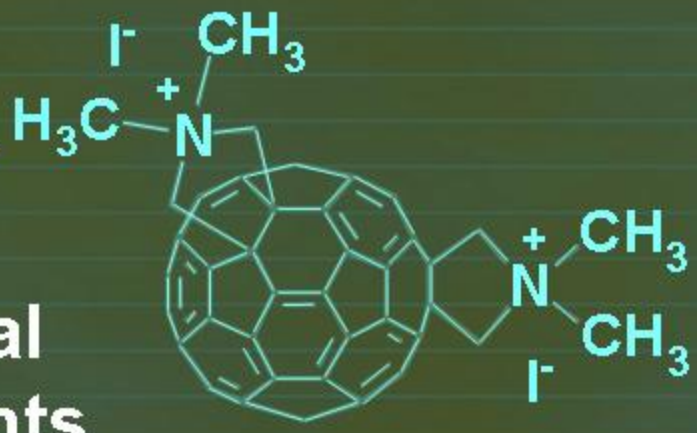


Cationic Derivative

Respiratory Chain Inhibitor

⇩

Anti-Cancer, Anti-Bacterial Agents



Prof. T. Mashino, Kyoritsu University of Pharmacy

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Proactive Toxicity Test of Commercialized Nanomaterials

Toxicology experiment of Bio-Fullerenes

Performed @ Mitsubishi Chemical Safety Institute Ltd.

Vitamin C60 Bio Research , affiliated company of Mitsubishi Corporation
Business startup with C60 derivatives "Radical Sponge" in cosmetic area

Disclosed data

- Acute oral toxicity testing（急性経口毒性）
- Primary skin irritation testing（皮膚刺激性）
- Cumulative application testing（累積刺激性）
- Skin sensitization testing（皮膚感作性　アレルギー誘発）
- Photosensitization testing（光感作性　アレルギー誘発）
- Phototoxicity testing（光毒性）
- Reverse mutation testing using microorganisms（変異原性）
- Chromosomal aberration testing using cultured mammalian cells（染色体異常）
- Human patch testing（人に付ける）

GLP（Good Laboratory Practice）- base

Reeource; Ｎｉｋｋｅｉ　Nanotech. http://nano.nikkeibp.co.jp/members/NEWS/20041109/11361/index.shtml

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Research on Bio-Effect of Nanocarbon Materials

Fullerenes

Pj "Carbon Cluster " by Prof. Eiji Osawa, 166 participants

1995~1997 Grants-in-Aid for Scientific Research, MEXT

A07 team: Influence of Fullerene on human body

Leader Dr. Masaaki Hirobe, Professor Emeritus at Faculty of Pharmaceutical Sciences, The University of Tokyo

①Pharmacological aspects

C60：No action is recognized in pharmacologic receptor of body, estimated from results o

C60 derivative: Suppress blood pressure reduction action of acetylcholine (Dr. Takayanagi

DNA breakage activity by active oxygen (Dr. Yamako)

Healing effect on cancer (rat) by UV light irradiation (Dr. Ikada、Dr. Tabata)

Polyvinylpyrrolidone solubilizing agent/ action of activated oxygen in C60

Hemolytic action of photosensitized erythrocyte

Differentiation and proliferation in rat embryonic osteoblast

Photosensitized mutagenic activity

Suppress mutagenicity of Carcinogenic nitoro-alene

Lipid hyperoxidation, DNA damage (Dr. Miyata)

continued

② Body related responses and analysis

In vivo counting on metabolic pathway of C60 in body

C61(COOEt)2/ Hepatic microsome

⇨ C60 epoxidation (mono-epoxy)

Use of P450 catalyst advances tri-epoxidation

✻ Metabolic process stops at this point

→ Great advantage for medical application of C60

Suppression of active oxygen by Water-soluble C62(COOEt)4

Eliminate super-oxide generated from xathine /xathine oxidase

Eliminate hydrogen peroxide by cytochrome c peroxidase activity

✻ Active oxygen multiplication agent inhibits body toxicity

→ medical application is expected

Prove suppression activity of water-soluble C62(COOEt)4

✻ Application for antimalarial agent is expected

✻ Degradation of C60 by white-rot fungus IFO31249 strain is found (Dr. Miyata)

Carbon Nanotubes

Pj "Tissue Reaction and Bio Application of Carbon Nanotubes, Nano Particles and Micro Particles"

Grants-in-Aid for Scientific Research, Ministry of Health, Labour and Welfare
2002 ~ 2004
By Prof. Fumio Watari, Department of Dentistry, Hokkaido University

Subjects (CNT);
1, Production of carbon nanotubes and its purification
Collaboration with Prof. Tohji, Tohoku University

2, Toxicity test of carbon nanotubes (in vivo)

3, Water soluble carbon nanotubes, chemical modification

4, Medical application of carbon nanotubes

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A Open Forum "Nanotechnology and Society"

Objectives; To create place and network for sharing information related to the societal impacts of nanotechnology

The first kickoff meeting; Aug. 5th, 2004

Invited speakers

Kick-off; 5th August
K. Naito:AIST, E. Osawa:NCRI, and M. Takemura:NIMS

2nd; 8th September
S. Kamei:MRI, H. Murayama:FCC, M. Misawa:AIST

3rd; 6th October
Y. Wada:Waseda Univ., T. Gamo:AIST, J. Nakanishi:AIST

4th; 25th October
G. Hunt:Surrey Univ., K. Shishido:NBCI, L. Liu:NRI

5th; 29th November
T. Kobayashi:NIES, Y. Osawa:NCRI, M. Ata:AIST

6th; 14th January 2005
A.Ono/H.Sakurai, Y. Tokumoto, Y. Negami

7th; 17th March 2005
K. Shishido, Y. Matsui

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Participants in the Forum "Nanotechnology and Society"

Private Sectors:
Nanotechnology Business Creation Initiative(320 companies),
Nano-Carbon Res. Inst., Frontier Carbon Corp., SCIVAX, Mitsubishi Res. Inst.,

Government;
Cabinet (Council for Sci & Tech Policy), METI, ME, MHLW

Independent Administrative Institution:
The New Energy and Industrial Technology Development Organization, NEDO
The National Institute for Materials Science, NIMS
The National Institute for Environmental Studies, NIES
The National Institute of Technology and Evaluation, NITE

Journalist; Nikkei NT, Syukan NT, Gendai Kagaku, Asahi Newspaper

Universities; Waseda Univ, Hokkaido Univ, Shizuoka Pref. Univ. etc

AIST Nanotechnology Res. Inst., Metrology Institute of Japan
Research Center for Chemical Risk Management
Technology Information Department

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A Symposium "Nanotechnology and Society"

1st February 2005 @ Nikkei Hall

Co-sponsored
by AIST, NIMS, NIES and NIHS
Sponsorship ;
METI, MEXT, ME, Nikkei Nanotech.,
Nanotechnology Business Creation Initiative

Main Guest;
Dr. Hiroyuki Abe, (Council for Science & Technology Policy, Cabinet)
Greetings;
Dr. Teruo Kishi, (President of The National Institute for Materials Science)
Dr. Yoich Gohshi, (President of The National Institute for Environmental Studies)
Dr. Taku Nagao, (President of The National Institute of Health Sciences)

Keynote Address;
Dr. Hiroyuki Yoshikawa, (President of AIST)
Lecture and Panel Discussion on Risk and Benefit of Nanotechnology

300 audience; mostly from private sector R&D management.

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NANOTECH2005 SATTELITE MEETING

AIST Symposium "Nanotechnology and Society"

Human resource development and technology assessment for public acceptance –

February 24, 2004 @ Tokyo Big Sight

Sponsored: AIST (Nanotech. Res. Institute)

Sponsorship: Nanotechnology Business Creation Initiative

PART I : Key note address (Human resource development)

PART II : Panel discussion (Human resource development)

PART III : Key note address (Technology assessment for public acceptance of NT)

Nanotechnology Standardization Panel (JSA-NSP)

Japan Standards Association set JSA-NSP on 11th November 2004.

Contribution to ISO/IEC

Communication with ANSI/ASTM and CEN

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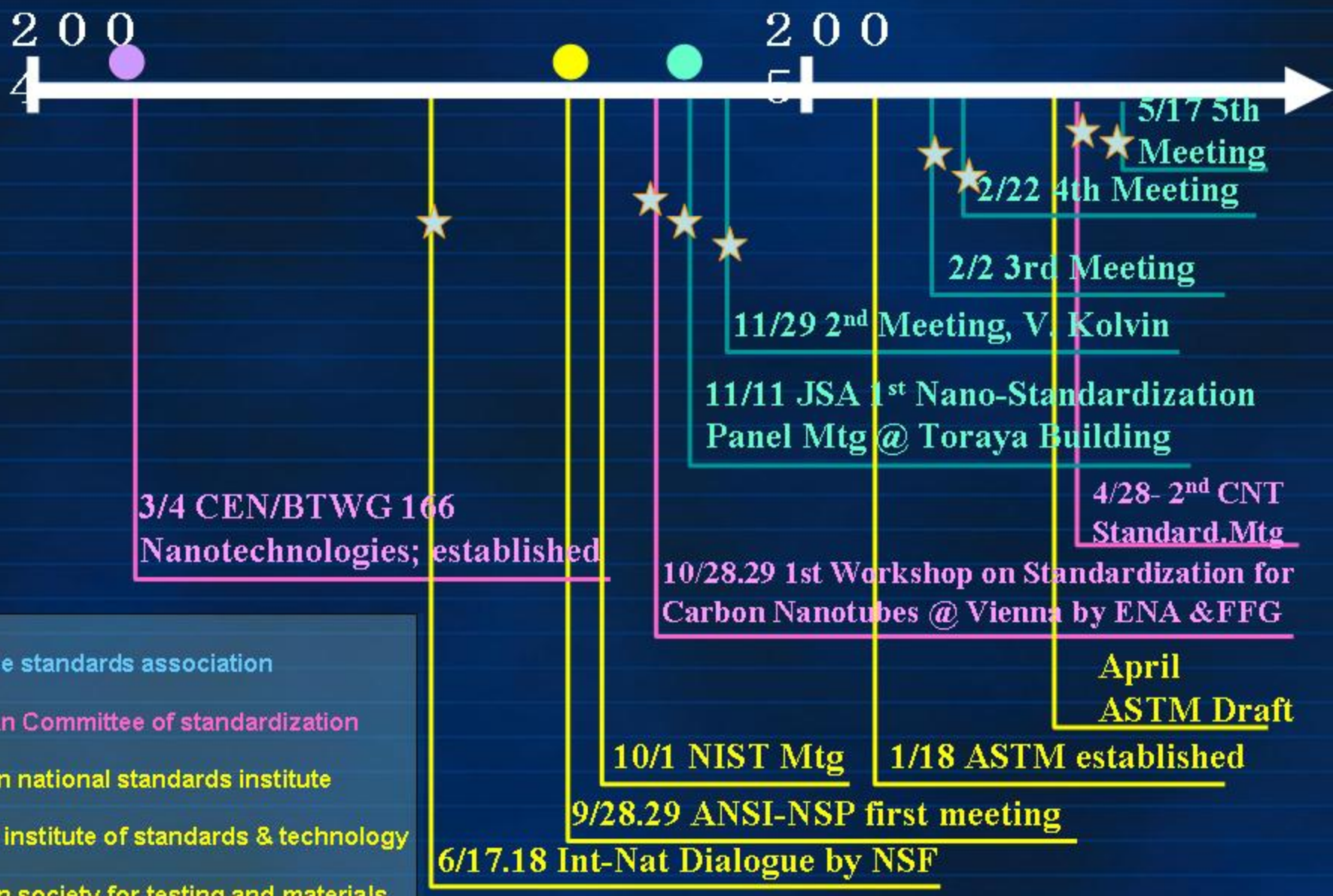
Trend of global nano-standardization



JSA:
Japanese standards association
CEN:
European Committee of standardization
ANSI:
American national standards institute
NIST:
National institute of standards & technology
ASTM:
American society for testing and materials

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Creation of Social Value

Gateway to Society

Science Communication

Risk Communication

Regulatory

Nano Risk Governance

Manufacturing

Process, Assemble, Integration, ,,,

Standards

Nano Standardization

Sharing the standards on Techniques and Definitions

Definition (Size, Terminology, Nomenclature), Nano Measurement and Testing, Nano Analysis, Methodology of Risk Assessment and Toxicology, Research on Environmental Emission of Nanomaterials

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Research Project

"Facilitation of Public Acceptance of Nanotechnology"

With the Special Coordination Funds for Promoting Science and Technology, FY'05, MEXT Pj Leader; Masafumi ATA

Ⅰ. Research and surveys on risk assessment of nanomaterial
by ＡＩＳＴ (Research Center for Chemical Risk Management)

Ⅱ. Research and surveys on health issue of nanomaterial
by National Institute of Health Science

Ⅲ. Research and surveys on environmental issue of nanomaterial
by National Institute for Environmental Studies, Universities

Ⅳ. Research and surveys on ethics and societal issue of nanotechnology
by National Institute of Materials Science, Universities

Ⅴ. Research and surveys on technology assessment for promoting the public acceptance of nanotechnology and economic effect
by AIST (Technology Information Department, the Nanotechnology Research Institute, Metrology Institute of Japan), Nanotechnology Business Creation Initiative, Universities, Journalists.

International Symposium on Public Acceptance of Nanotechnology
February 1st, 2006 @ United Nations University, Tokyo

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Thank you for your attention !

Masafumi-Ata@aist.go.jp