Toward further development of Nanotechnology Platform

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In this presentation, I will describe a brief outline of Nanotechnology Platform of MEXT, which established culture of facility-sharing and has produced many outstanding results, and I will raise a problem for further future development.
Background

- Advanced microstructure analysis equipment / microfabrication equipment is a research infrastructure that is indispensable for the development of IoT devices aiming at Society 5.0, but as its sophistication advances, prices become too expensive for researchers to purchase with a normal research budget.

- However, such an equipment was unevenly distributed only to some national research institutes, universities, laboratories, and was not opened to other researchers.

- Maintaining these devices requires specialized personnel with advanced skills, but universities and research institutes have become difficult to maintain such human resources.

- The large enterprises who have abandoned their own principles at the time of the open innovation era have stronger desire to utilize advanced nanotechnology equipment maintained by public funds.
Type of common use: Research base of each country

- In the United States, South Korea and Taiwan, 10% to 15% of the nano technology state investment amount was systematically used for forming a shared facility network/base, and a network of highly advanced research infrastructure was constructed.

- In particular, the US NNIN (now NNCI), NCN (NSF) and Korea’s six centers are almost complete as a common infrastructure for charging system and international correspondence. In Europe and Taiwan, networks of nanotechnology research infrastructure are formed by country/region unit.

- In the fulfilling dozens of bases networks in the United States, funds from the Federal Government are funded by about 30% of the total operation cost, taking full advantage of the many years of experience of the shared center.
Nanotechnology Platform Project of MEXT started in 2012 FY

- Overseas, a network of nanotechnology infrastructure centers represented by NNIN (now NNCI) in the United States has been developed, and by sharing equipment, companies from all over the world gather and are promoting R&D.

- In Japan, we can not expect a drastic increase in the country's R & D budget. Recently, we need to take root in new R&D culture by sharing equipment and knowledge.

- Under the background, the nanotechnology platform business started in 2012 FY.

- Nanotechnology Platform is a 10-years project, aiming at establishing a nationwide sharing of facilities, by a close collaboration with the institutions with the most advanced research facilities on nanotechnology and know-how on utilization of precedent nano-support and nano-net projects.

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<th>Nano-support</th>
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<td>2002-2006</td>
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<td>2012-2021</td>
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Purpose of the Project

- To maximize R&D investment efficiency of industry, academia and government relating to nanotechnology, materials and devices.

- To promote common use of advanced facilities by diverse users of industry, academia and government, to provide approaches to solving technical problems of industry and research sites, and to promote industrial-academia collaboration and fusion of different fields.
Fostering a new research culture

- From ownership to share (cycle of human beings, money, knowledge)
- From “vertical” (splitting) to “transverse” (fusion)
- From “close” to “open”
- From “analog” (independent) to “digital” (networking)
- From “local” (regional) to “global” (international)
- From personal viewpoint to user’s viewpoint
- From investment for own research to investment for solving user’s problems
- From relying on public funds to diversifying resources (Management sustained with appropriate usage fee accounting)
- From “flow” supremacy to “stock” emphasis
- From “traditional” areas by researchers in specific fields to interdisciplinary collaboration to develop “new areas”
Outline of this project

- By forming three platforms corresponding to (1) advanced characterization nanotechnology, (2) nanofabrication, and (3) molecule & material synthesis, we provide industry, academia and government with cutting-edge measurement and evaluation, processing and material synthesis environments, as well as advanced support technology and knowledge.

- The annual number of platform use amounts to about 3000.

- The entire platform is managed by combined budget of the project budget of the MEXT, the fee income from users, and the burden budget by the executing agency.
Promotion system of nanotechnology platform
(25 corporations nationwide, 37 organizations)
## Construction of Nanotechnology Platform

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<td>Center</td>
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Implementation system

1. Adjusting & Promotion
   - Advanced Characterization Nanotechnology PF (11 organizations)
     Representative: NIMS
   - Nanofabrication PF (16 organizations)
     Representative: Kyoto U.
   - Molecule & Material Synthesis PF (10 organization)
     Representative: IMR

2. General contact / public relations

3. Industry-academia collaboration / interdisciplinary integration

4. Human resource development, international partnership, exchange of technical supporters, student training

MEXT
PD: K. Sato
PO: T. Nagano, R. Tanaka
Planning & Evaluation

Chairman: PD
Member: Sub PD, POs, Counselor of NT (General Secretary), Professional member
Secretariat (Counselor’s office)

Science and Technology · Academic Council

Program Steering Committee

Research planning and evaluation subcommittee

Nanotechnology Material S&T Committee

Chairman: · Chief
Member: Committee member, Extraordinary Commission, Professional Commission

- Advise for PF from professional viewpoint
- Evaluation of PF
- Report to Research planning and evaluation subcommittee
People surrounding the Ecosystem of Nanotech Platform

Number of Use: 13,437 (5 years)
Number of Users: 16,042
Percentage of new users: 53% (averaged)
Percentage of repeaters: 47% (averaged)

User attributes:
Industry 27% (large enterprise 20%, small business 7%)
University 64% (28% inside the university, 36% outside the university)
Public agency 7%
Other 2%

Participating staff of the nanotech platform
- Nanofabrication PF 271
- Adv. Char. Nanotech PF 319
- Mol. & Mat Synthesis PF 251
- Center Organization 27

Total 868 (including 258 staffs employed by this project)
In addition to representatives, coordinators, coordination managers, administrative staff, experts, highly specialized technicians, specialized technicians directly correspond to technical services

The data is based on statistics of 2016FY
Nanotechnology Platform offers rapid R & D infrastructure functions essential for industry and academia.

The number of applications was about 1000 annually in the previous nano-net era, but in nano-plat, it reached 3000 in FY2007. Among them, the use of enterprises has reached 27% of the total.
Usage status by usage type

Equipment usage is mainstream, but technical agency tends to increase.

Usage Type is different for different PF

Number of Usage

Usage Type is different for different PF

Nanofab PF

Adv. Char. PF

Mol. & Mat. Synthesis PF
Flow of using Nano-Plat

- **Payment of Usage Fee**
  - For results submission (simple usage report, applications can be postponed about two years for reasons such as patent submission, etc.)
  - Payment of prescribed usage fee (utility and water expenses, expendable items, etc.)

- **Type of Usage**
  - Equipment Use, Technical Assistance, Technical Agent, Joint Research, Technical consultation (charged), trial use (free)

- **Intellectual property**
  - Rights are based on arrangements with each agency (in principle, they belong to users in normal equipment use)

- **Upon application, sign a usage contract**
  - (There is a simplified method)

- **Consulting Application**
  - **Discussion**
  - **Decision of Support, Implementation**
  - **Recommendation to another PF**
  - **Submission of Report after usage**
  - **Payment of Usage Fee**

System for usage with no obligation of publication depends on each organization.
General Contact
(Center Institution)
Confirmation of executing agency's awareness at site visit

PD and PO accompanying with the officials with Counselor of Nano / Materials of MEXT make site visit to each executing agency to grasp the current situation, and help to solve the problem.

Since the project is a long-term project with a period of 10 years, it is not necessarily that there are cases where the responsible persons of the executing agency are replaced and the original intention is not succeeded. At the site visit, we are requesting the inheritance of each institution's original intention and responsibility awareness.
Public Relations / Promotion of use (Center Organization)

Public relations activities at exhibition presentations and academic societies exhibitions

- Publication of Achievements at Japan Nano Symposium (Tokyo Big Site)
- Presentation and Exhibition at Academic Society Meetings such as JCS, JSAP, NBCI, JASIS, Semicon-Japan
- Working with SMEs and Public Examination by Cooperation Manager (until 2017 FY)
Recognition of Excellent Utilization Achievement

A lot of research results have come out from Nanoplat. At the end of each FY, a commendation by experts will select several "outstanding utilization outcomes" and the best award from among them and will be honored at the Nanotechnology Japan site.

- Best Awards of each FY
  - 2017FY “Ga₂O₃ Trench MOS-Type Schottky Barrier Diodes” (User: Novel Crystal Technology Inc., Support: NIMS)
  - 2015FY “Synthesis and analysis of 3,4-dichloromethylphenidate” (User:NIT, Support: IMS)
  - 2013FY “Development of Silicon Electret Microphone” (User: Rion, Support: Tohoku Univ.)

These achievements were evaluated for their contribution to solving social problems.
Human resource development

(Improvement of technical skill of PF technical support person, user, student)

Mutual offering of full training menu from all agencies for technical supporters and users. We offer each exclusive menu for students. New device skill · To acquire advanced knowledge

► Provision of technical skills training to more than 200 technical assistants employed in Nanoplat
  → Start function assignment system according to mastery skills (Experts, highly specialized technicians, specialized technicians)
► Define skill standards, review each PF, grant through committee
  → Short-term training opportunities for similar organizations in Europe and the United States
► Contributing to skill improvement and human resource development of users
► Provide training programs for students nationwide, accepted by public offering
Recognition of "Takumi's technique"

It is also an important mission of this project to appreciate the "skill of the artist" of the technical staff who is a rich subordinate existence and promote career formation.

- **2017FY Technical Staff Recognition**
  - Excellent Technology Award: A. Kumamoto (Univ. Tokyo)
  - Excellent Technical Support: Y. Kishimura (Microfab PF, Yaomaguchi Univ.), H. Ando & S. Takeuchi (FAIS)
  - Young Staff Encouragement Prize: K. Higuchi Nagoya Univ.

- **2016FY**
  - Excellent Technology Award: S. Arai (Nagoya Univ.)
  - Excellent Technical Support: K. Okitsu (Univ. Tokyo)
  - Young Staff Encouragement Prize: Y. Yamamoto (Nagoya Univ.)
Contribution to promote university system reform

- Nanotechnology Platform triggered the creation of a shared system in various universities and induced rule reform.

- In particular, the management method of the accounting model and the income / expenditure structure was also used as a reference for other universities and other projects.

- In the Infrastructure Sharing Promotion Project of MEXT, the experience and mechanism of Nanoplat is widely used and developed (→right figure)

80 Research organization from 39 institutes have introduced the new Infrastructure Sharing System of MEXT.
Outline of mid-term evaluation(1)

Mid-term evaluation was performed in 2014 and 2017 FY. Here outline of the latter is introduced below.

(1) Overall situation and evaluation

- Utilization number and usage fee income are increasing year by year, utilization is fixing and expanding, the number of related papers and the number of patent applications are also increasing year by year. The collaborative system with the representative organizations and executing agencies of each platform (hereinafter referred to as PF) is well functioning, and improvement of convenience is attempted.

- The number of citations of research papers supported by this project is steadily increasing as a contribution to the improvement of research capabilities of universities and other institutions. Since the top 1% citation and the top 10% paper are also included, it is clear that high quality research is supported.

- As a result of this project, sharing of facilities and introduction of charging system are advancing, contributing to reform of common system in university. It contributes to effective utilization of research and development budget of the country, improvement of research efficiency, and allows accumulation and succession of experience and knowledge on nanotechnology, materials science and technology.

- The Nanotechnology Platform has engaged in training human resources such as training for improving skills of technical support personnel employed in this project, function name granting system for motivation improvement, technical support person awards.
Outline of mid-term evaluation (2)

(2) Situation and evaluation of each PF

【Advanced Characterization Nanotechnology PF (Representative: NIMS)】
- Highly appreciated the point that it has the function of independently developing analysis technology.
- Evaluate unique measures such as collaboration with analytical company, sharing of technical needs trend by the council, utilization of big data, etc.
- We expect to respond to new fields in the future. For executing agencies with large research facilities, we expect measures to expand usage

【Nanofabrication PF (Representative: Kyoto Univ.)】
- The number of uses, usage fee income, use from companies, etc. are growing, leading to productization from technical support.
- Evaluate the system of providing provision of quality guaranteed across the executing agency and the system for using consultation and technical consultation with a coordinator inside the representative organization.
- As a measure to respond to requests for technical agency and support, we evaluate active attitude towards act, including considering "new substitution model". Looking forward to strengthening efforts to improve the quality of support

【Molecule & Material Synthesis PF (Representative: IMS)】
- It can be seen that there are many citations of research papers and that they provide academically high-quality support. The synthesis support function is valuable and highly appreciated.
- Molecular and material synthesis is the essence of nanotechnology and we strongly expect leadership of representative organizations to make effective use of this PF.

【Center Institutions (NIMS, JST*)】*Ended work as center institution in 2017 FY
- Strengthening the integral efforts of the entire project by the administrative officials' conference etc., sharing problems, expanding new users, promoting industry-academia-government cooperation promotion managers to develop different fields, efforts of “trial use” project, etc.
- We plan the outcome presentation meeting and business introduction symposium etc and devoted ourselves to recognition of this project. Efforts such as awards to users and executing agencies and recognition of technical support persons, etc. are evaluated from the viewpoint of securing incentives for both users and supporters.
Future direction of the platform

- Predicting the trend of science and technology fields from now on, planning again the strategy that should exist as PF, and reviewing such as replacing some executing agencies and providing technologies from the viewpoint of efficient provision of assistive technology.

- To further promote the sharing of equipment and to further improve the external sharing ratio, review the lineup of registered equipment.
Approach to improvement by receiving mid-term evaluation

1. Strengthened response to changing needs for corresponding areas IoT, Bio etc.
2. Strengthening of careers of staff and review of equipment lineup
3. Scheduled to report on strategy planning "Advanced shared facilities / technology platform perspective WG"
4. Usage fee calculated from the provisional market price with the required cost execution amount, provided value in mind, PF actual circumstances consideration
5. PF will advance internationalization of the environment.
6. Activities of the project widely communicating the outcome and results, conduct activities to gain understanding
7. Contribution to reform Act as much as possible to promote reform of the system
8. Particularly cooperate with NIMS’s Information Integrated Materials and Materials Research Base (MI 2I)
9. Make note of the three aspects of scientific excellence, promotion of innovation, contribution to the region
10. Efforts to further enhance the external sharing ratio of external common promotion equipment
Breakthrough of bottlenecks in improving quality of support and responding to new support

- In order to break the situation that is a bottleneck in improving the quality of support and responding to new support requests,
  - Increase in maintenance costs associated with long-term use of equipment
  - Replacing outdated equipment to state-of-the-art
  - Staff’s term of employment with assistance is becoming obvious.

- I would like to request drastic and continuous policies of the country.
  - Clear separation on the budget of research expenses and research facilities.
Future issues: Direction of initiatives

- Growth and leap of the nanotechnology platform for 7 years, next to the nano-net 10 years
  - The ecosystem surrounding PF is evolving → dealing with impeding factors
  - Responding to new services, new technologies and new devices that can fight in the world
    - Data PF collaboration
    - Strengthen responsiveness of bio and IoT areas
    - New technology development
    - Repair / renewal of aged equipment
    - Strengthen international partnership and exchange

- Promote reform of universities and national universities, Nano-Platform constantly stepping forward, contributing to society as a third mission lineup of university research, education
  - Promotion of cooperation with other projects and other organizations
  - Evaluation of professors / staff who contributed
  - Promotion of career development

Thank you for kind attention