For discussion
On 10 February 2003

LegCo Panel on Commerce and Industry
Development of Nanotechnology in Hong Kong

Purpose

This paper -

(a) informs Members of the action taken by the Administration in supporting the development of nanotechnology in Hong Kong; and

(b) outlines the Administration's proposal to support applied research and development in nanotechnology under the Innovation and Technology Fund (ITF).

Background

2. On 31 October 2001, a motion on "developing nanotechnology" was carried by the Legislative Council. The motion urged the Government to develop nanotechnology, with a view to fostering the development of the local economy.

3. Nanotechnology is a broad and interdisciplinary area of research and development concerning technologies in manipulating atoms and molecules at nanoscale level and creating nanostructures with fundamentally new organizations and properties. The interest in the field of nanotechnology or nanostructure science and technology is growing rapidly, and many countries are putting substantial resources in R&D in this new technology area.

4. A combination of government funding, corporate-academic collaborations and funding by venture capitalists have been providing support for pre-competitive research and development on nanotechnology. The world leaders in this technology area are United States, Japan and Europe. In recent years, all of them have launched large scale national programs, and most of them are establishing centres of excellence in

specific areas of nanotechnology. For example, the United States launched a comprehensive plan, the National Nanotechnology Initiative (NNI), in 2000 with an annual budget of about US$500 million allocated to R&D in nanotechnology. The amount of funding on nanotechnology is increased to approximately US$604 million in 2002 and a total budget request for 2003 is about US$710 million. For the Mainland of China, about 2 billion RMB (US$240 million) was allocated in 2001 for a five-year programme on nanotechnology.

5. In Hong Kong, various types of nanoscience and nanotechnology research are carried out at the six universities. Although nanotechnology related research is rather new in Hong Kong, the Government has already provided more than HK$107 million in the past few years to support basic and applied research projects in this technology area through the Research Grants Council (RGC) and the Innovation and Technology Fund (ITF). Nanotechnology related projects are mainly found in engineering and physical science communities, and they focus mainly on the following three broad areas, namely, nano-materials, nano-electronics and nano-biotechnology.

Follow-up Action Taken

6. In early 2002, the Administration circulated a progress report on the follow-up action taken in supporting the development of nanotechnology in Hong Kong covering the period up to 31 March 2002.

7. Further to the motion debate, the Administration briefed the Panel on the findings of the review of the ITF at its March meeting in 2002. The review identified nanotechnology as one of the key technology areas for priority development. In order to achieve a sharper focus in research into the area of nanotechnology and to create an impact, the Commission issued a solicitation theme on nanotechnology under the Innovation and Technology Support Programme (ITSP) of the ITF and invited applications in July 2002.

Applied Research in Nanotechnology

8. While the RGC supports upstream and academic research in

nanotechnology, the ITF supports mid-stream to downstream research projects with particular emphasis on the commercial potential and possibility of technology transfer of project deliverables to the relevant industries.

9. In 2002, we approved seven ITF projects concerning mid-stream and downstream R&D in nanotechnology with a total funding of $41.5 million. Some of the projects are related to the development of nanocatalytic systems for environmental and industrial treatment applications, high performance nanoelectronics for telecommunications and high capacity compact power cells.

10. The project deliverables from these approved projects would have commercial potential and could be transferred to the local industries for further development and commercialization. In fact, we have seen initial success of some of the projects, e.g. an ITF project which aims to develop the commercial applications and technologies on the photocatalytic coating of nano-sized titanium dioxide (TiO2) powder has successfully developed an air filter coated with TiO2 which proves to have excellent air cleaning effect. The developed technology has been transferred successfully to a local company for the development of air filter and water filter.

Solicitation Theme

11. In July 2002, the ITC issued a solicitation theme on nanotechnology and invited applications from the universities and the Applied Science and Technology Research Institute (ASTRI). Given the interdisciplinary nature of nanotechnology, the objectives of the solicitation theme are to create synergy, collaboration and greater impact through the integration of individual efforts with a view to bringing techno-economic advancement in Hong Kong. Having regard to the current strength of the research groups in Hong Kong, our focus on the development of functional nanomaterials for commercial applications in energy storage, telecommunications, optoelectronics, textile, biomedical, environmental industries, etc.

12. A Nanotechnology Projects Vetting Committee (NPVC) comprising both local industrialists and international experts in the field of nanotechnology was set up to assist the ITC in assessing the applications. A copy of the membership of the NPVC is attached at **Annex A**.

13. Applications from five institutions in response to the solicitation theme were received and the NPVC visited these institutions in November 2002 to understand their research capabilities and the facilities available in the area of nanotechnology. Having thoroughly examined the five applications, the NPVC recommended that two of the applications should be supported.

14. The two applications recommended for funding support by the NPVC are -

(a) establishment of a Nanotechnology Centre for Functional and Intelligent Textiles and Apparel from the Hong Kong Polytechnic University (PolyU); and

(b) development of Functional Nanomaterials and Technologies from the Hong Kong University of Science and Technology (HKUST).

15. PolyU's project aims to improve properties of fabrics through the application of nano-finishing and nanotechnology. The project deliverables include -

(a) textile and apparel products which exhibit multifunctional properties such as ultraviolet resistant, stain and water-repellent and anti-bacterial;

(b) intelligent textiles that could respond to different environment; and

(c) nano-structured photonic fibers which could be developed into fabric displays.

Details of PolyU's project are at **Annex B**.

16. The project team will bring together researchers from different disciplines, e.g. applied science and textiles, applied biology and chemical technology. As the research program would upgrade the technology base of textile and clothing industry and bring about high value added products through development of nanomaterials, the NPVC supported the project proposal. The total cost estimate of PolyU's project is $14.702 million. The University has secured a total sponsorship amounting to $2.22 million from the relevant industries, and the net amount requested from the ITF is

$12.482 million and the ITC is processing the application in accordance with the established procedures.

17. HKUST's project aims to develop high potential applications in nanotechnology. The project deliverables contain some near-term commercial applications and technologies including -

(a) "Energy storage: Microfuel Cells". The eco-friendly microfuel cells with nanostructured materials and miniaturized architecture have enhanced performance for portable electronic devices such as mobile phones and handheld personal digital assistant (PDA);

(b) "Nanoelectronics: Displays". Tremendous demand for better performance and new applications drive display technologies to advance progressively. The application of nanotechnology has recently made important contributions to this evolution; and

(c) "Integrated Manufacturing of Nanomaterials". This would lead to enabling technologies to produce high yield nanomaterials at a low cost. The nanomaterials including carbon nanotubes, fullerenes and nanoparticles would be developed to possess desired properties for the above applications.

Details of HKUST's project are at **Annex C**.

18. The NPVC considered that -

(a) HKUST had identified certain niche areas in which they could build on its strengths to create greater impact in nanotechnology for the region;

(b) the project team had good track record in nanotechnology worldwide, including the core competence in nanomaterials and nanoengineering research;

(c) the management structure contained in the project proposal was effective and the project had demonstrated that they had collaborative efforts within/outside the institution and the industry for the research and development work; and

(d) the project proposal received significant contributions from eight relevant industrial partners.

19. The NPVC concluded that the applications and technologies developed in this research programme would bring economic benefits and opportunities to Hong Kong. Since the project, if successfully completed, could put Hong Kong on the map in nanotechnology development, the NPVC supported the funding of this project.

20. The total cost estimate of HKUST's project is $63.236 million. The University has secured a total sponsorship amounting to $6.325 million from the relevant industries, and the net amount requested from the ITF is $56.911 million. The project will be funded from the existing funding of the ITF.

Way Forward

21. The Administration will ensure that the momentum that it has created will be sustained through the current funding programmes, the activities of existing research institutions and their collaboration with industry. As regards the funding of the project to be carried out by the HKUST (see paragraphs 17 - 20 above), since the amount of funds requested from the ITF exceeds $15 million, we will need the Finance Committee's approval as this is above the funding ceiling for Category D projects in the Public Works Programme (currently $15 million). Subject to Members' comments, we will seek the approval of the Finance Committee in April 2003.

Commerce, Industry and Technology Bureau
January 2003

Annex A

Membership List of
Innovation and Technology Fund
Nanotechnology Projects Vetting Committee
創新及科技基金
納米科技項目評審委員會名單

Chairman 主席	Permanent Secretary for Commerce, Industry and Technology (Information Technology and Broadcasting) OR Commissioner for Innovation and Technology	工商及科技局常任秘書長（資訊科技及廣播） 或 創新科技署署長
Members 委員	Mr Daniel Cheng Group Managing Director Dunwell Industrial (Holdings) Ltd	鄭文聰先生 正昌環保科技（集團）有限公司 董事總經理
	Mr K O Chia Managing Director Walden International Hong Kong Ltd	謝國安先生 華登國際香港有限公司 總裁
	Mr George Chung Chairman Standard Telecommunications Ltd	龔念祖先生 標準電訊有限公司 主席
	Dr Eric Lean Advisor to Chairman SAE Magnetics (HK) Ltd	林耕華博士 東莞新科電子廠 顧問
	Dr Harry N S Lee, SBS, JP Managing Director TAL Apparel Ltd	李乃熹博士 聯業製衣有限公司 董事總經理
	Dr York Liao, JP Managing Director Winbridge Co Ltd	廖約克博士 Winbridge Co Ltd 董事總經理

Dr Hon M W Lui, JP
Managing Director
Keystone Electronics Co Ltd

呂明華博士
文明電子有限公司
董事總經理

Dr T L Ng, BBS, JP
Managing Director
Operations, Global Lighting Products
Energizer Company Inc

伍達倫博士
勁量有限公司
董事總經理

Mr C D Tam, JP
Chief Executive Officer
The Hong Kong Science and Technology Parks Corporation

譚宗定先生
香港科學園公司
行政總裁

Dr Daniel Herr
Director of Material and Process Sciences Research
Semiconductor Research Corporation
United States

Dr Theodore I Kamins
Principal Scientist
Quantum Science Research
Hewlett-Packard Laboratories
United States

Prof Thomas F Kuech
Department of Chemical Engineering
University of Wisconsin
United States

Prof Albert F Yee
Director
Institute of Materials Research and Engineering
Singapore

Prof Peter Y Yu
Department of Physics
University of California
United States

Annex B

PolyU's Proposal

1. Project Title

Nanotechnology Center for Functional and Intelligent Textiles and Apparel

2. Abstract

We propose to establish a Nanotechnology Center specifically for the textile and apparel industry in Hong Kong, which is one of the five largest exporters of textiles and apparel products in the world. This Nanotechnology Center will further strengthen the competitiveness of the industry by achieving the four-fold objectives: (1) to provide research and development infrastructure for textiles and apparel related nanotechnology, (2) to develop new nanotechnology and products for functional and intelligent textile materials and apparel; (3) to facilitate technology transfer to and collaboration with the industry, and (4) to provide training to postgraduate students and company technical personnel.

Nanotechnology has been regarded as an essential enabling technology for the next generation of fiber based functional and intelligent textile materials and apparel. Our multi-disciplinary research team actively worked in the area and demonstrated several new technologies with very promising industrial application potentials in the past. The three-year program will extend our past research activities and develop the fundamental research into technology for industry. The program of the Center will focus on nano-finishing systems and nanotechnology for intelligent textiles and apparel products. The projects are devoted to investigation and development of environmentally friendly and effective nano-finishing processing systems for textile fabrics and garments, including surface polymerization system, systems for precise manufacture of nano-particles, nano-scaled polymer bulk treatment system and printing/chemical vapor deposition system. These newly-developed processing systems will be used for producing various functional or smart/intelligent products, such as sensing textiles and apparel as well as nano-structured photonic fibers and films.

3. Objectives

The main objectives for the Nanotechnology Center for Functional and Intelligent Textiles and Apparel are:

(1) to provide research and develop infrastructure for textiles and apparel related nanotechnology,
(2) to develop new nano-materials, new processing technologies and products for high-value-added functional and intelligent textiles and apparel,
(3) to facilitate technology transfer to and collaboration with the industry, and
(4) to provide training to postgraduate students and company technical personnel.

4. Deliverables

The four research projects have the following agreed outcomes:

(1) Optimized surface polymerization systems for UV-blocking, stain-, water-, and oil-repellent, anti-bacteria finishing of cotton, polyamide and polybenzimidazole fabrics, nano-pigment coloration system.
(2) Customer tailored synthesis systems for precise size and sensitivity control of nano-structures for functional finishing and photonic fibers
(3) Optimized fabrication system for conductive textiles sensing devices for strain, temperature and relation humidity, and a prototype of electrical sensing apparel
(4) Prototypes of photonic fibers that can regulate light intensity and color and a prototype of 2-colored display fabric made from such fibers.

In addition, the Center will acquire one equipment, set up designated laboratories and offices, train several postgraduate research students, conduct training courses for company personnel, and carry out other promotion activities.

5. Budget

5.1 Expenditure

	Total ($'000)
Manpower (including project manager, 3 research fellows, 6 research associates and 4 research assistants)	10191.726
Equipment (including research equipment)	1750.000
Other Direct Costs (including consumables, chemicals, etc.)	2760.000
Sub-total :	**14701.726**

5.2. Amount of Sponsorship

Sub-total :	**2220.000**

5.3. Net Amount Requested from the Innovation and Technology Fund

Total Expenditure ($'000)		**Total Sponsorship ($'000)**		**Net Requested Amount ($'000)**
14701.726	-	2220.000	=	**12481.726**

Annex C

HKUST's Proposal

1. Project Title

Institute of NanoMaterials and NanoTechnology (INMT): Development of functional nanomaterials and technologies

2. Abstract

The goal is to establish an Institute for the development of nanomaterials and nanotechnologies that have multiple applications and product potentials in partnership with industry, and other educational and research institutions. The four-year program comprises of three core areas: Energy storage: Microfuel cells based on ultra-small carbon nanotubes, fullerenes, nanoporous membranes and nanoparticles; Nanoelectronics: Displays based on ultra-fine nanostructures made with organic and inorganic materials; and Integrated manufacturing technologies for nanomaterials including CNTs and fullerenes, and nanoparticles including organic and inorganic compounds. Three existing nanotechnology projects – batteries, transistors and catalysts – will be incorporated into the Institute management to maximize the synergistic benefits.

The Institute with four core areas (the fourth being Environmental catalysts) will serve as a regional and international focal point for advances in nanotechnology. Technology transfer and commercialization will be promoted by the Institute, thus leading to the development of new nanotechnology-based industries in Hong Kong and the Region.

3. Objectives

We propose to establish an Institute of Nanomaterials and Nanotechnology (INMT) in partnership with industries, to be housed at HKUST, for research, development and application of nanomaterials/devices that are relevant to the economic growth of Hong Kong and the Region.

INMT will develop critical midstream research capability for Hong Kong's development in nanomaterials and nanotechnology through:

(1) Establishing the Institute as a world-class nanomaterials and nanotechnology R&D center for technology development, technology transfer, industry partnership, and international collaboration.
(2) Developing core competence in critical areas of nanomaterials and nanotechnology that can lead to potentially new commercial products and processes and can enhance existing foundation industries in Hong Kong and the Region.
(3) Enhancing Hong Kong's human resources in nanotechnology (scientists, engineers and entrepreneurs) for the present and future needs of Hong Kong and the Region.
(4) Acting as a regional and international focal point for nanomaterials and nanotechnology R&D through a multidisciplinary and multi-institutional collaborative approach by providing linkage and cohesion to fundamental

research, engineering processes, and industrial applications.

4. Deliverables

Midstream R&D is the focus of the proposed Institute. For each of the core areas, a number of well-defined deliverables are proposed. They are highly relevant to the region, and are well received by our industrial partners. Our approach is to have continuous interaction with our industrial partners to refine the specifics of these deliverables and to develop the technologies that are suitable for technology transfer. The major deliverables for each new core area are listed as follows:

Energy storage: Microfuel cells

(1) Inorganic proton transport membranes based on nanoporous zeolite and molecular sieve materials.
(2) Increase the proton transport across the nanoporous zeolite membrane by 25 %, decrease interfacial resistance of zeolite membrane by half and improve the mechanical strength to withstand 60 psig.
(3) A twenty percent improvement in catalyst material for direct fuel conversion in microfuel cell device compared to PtRu (1:1) catalyst.
(4) Replacement of catalyst support and electrode materials using nano-carbon materials (e.g., carbon nanotubes (CNT), carbon nanohorns and fullerenes).
(5) Computer program to simulate fluid flow, heat and mass transfer properties in microfuel cell system with the goal of designing optimum architecture for solving water, heat and mass transport related problems.
(6) Establish microfabrication protocols to implement the microfuel cell design architecture that will enable the incorporation of new membrane, catalyst and electrode materials.
(7) Implementation of industrial standard, economical adaptation of microfuel cell unit to existing and emerging electronic devices for IT and communication applications.
(8) Manufacturing process specification and pilot plant design and feasibility evaluations.

Nanoelectronics: Displays

Deliverable One:

A bistable LCD that can be driven once and retains its content without any applied voltage. We shall deliver such a display for smart card application. It will be small size with a 7-digit numeric segment display. We shall also deliver another display with a higher resolution (120x160) in a 2” diagonal format for application in cell phones. A bistable 2” diagonal electrochromic display based on nanoparticles.

Deliverable Two:

An organic light emitting diode display with enhanced external coupling using nanostructured surfaces. We shall target a coupling efficiency enhancement of 2X as compared to devices without this nanostructure. We shall deliver such a display with a 120x160 resolution in a 2” diagonal format for cell phone applications. The

brightness will be 300 Cd/m^2 with a power efficiency of at least 10 lm/W.

Deliverable Three:

An active matrix organic light emitting diode display using our nanoparticle induced low temperature polycrystalline silicon technology. We shall deliver a QVGA resolution (240x320), 3.5" diagonal display, with fully integrated internal drivers. We shall use micro-color filters and make this a full color display. This display can be useful for PDA applications.

Manufacturing technologies of nanomaterials and related products

We will provide process flowsheets, operating conditions and process economics for the manufacturing of (i) fullerenes, (ii) CNTs and (iii) nanoparticles. Fullerenes will be produced in the form of pure C_{60} and pure C_{70}. Both single wall and multiwall CNTs will be produced. Zeolite seed particles, Pt, TiO_2, SnO_2 and $NiSi_x$ nanoparticles will be produced. While the process can be scaled according to the desirable production rate of our industrial partners, we will aim for a design of 0.1 kg/hr production rate. The level of organic impurities will be kept below 0.1 % by weight for fullerenes and CNTs. We will aim for a product cost below $1 per gram for fullerenes, and a similar order of magnitude for CNTs.

5. Budget

5.1 Expenditure

	Total ($'000)
Manpower (including institute director, technical manager, 12 research associates, 17 research assistants, 6 technicians and 1 project assistant)	35930.000
Equipment (including research equipment and pilot line facilities)	16976.000
Other Direct Costs (including consumables, chemicals, etc.)	10330.000
Sub-total :	**63236.000**

5.2 Amount of Sponsorship

Sub-total :	**6325.000**

5.3 Net Amount Requested from the Innovation and Technology Fund

Total Expenditure ($'000)		Total Sponsorship ($'000)		Net Requested Amount ($'000)
63236.000	-	6235.000	=	56911.000

6. Cashflow

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Subtotal ('000)**
Manpower ($'000)	8850	9330	9510	8240	35930
Equipment ($'000)	12374	1950	2452	200	16976
General Expenses ($'000)	2405	2575	2835	2515	10330
Annual Budget ($'000)	23629	13855	14797	10955	
Total ($'000)					**63236**