For discussion **FCR(2003-04)2**
on 11 April 2003

ITEM FOR FINANCE COMMITTEE

INNOVATION AND TECHNOLOGY FUND
HEAD 111 – INNOVATION AND TECHNOLOGY
New Subhead "Development of functional nanomaterials and technologies by the Hong Kong University of Science and Technology"

Members are invited to approve the creation of a new subhead "Development of functional nanomaterials and technologies by the Hong Kong University of Science and Technology" under Head 111 "Innovation and Technology" with a commitment of $56,911,000 to establish an Institute of Nanomaterials and Nanotechnology for developing functional nanomaterials and technologies.

PROBLEM

Nanotechnology will be one of the most important technology platforms, after information technology and biotechnology, to offer major breakthroughs and opportunities for industry in the 21st century. Most developed countries are putting substantial resources in the research and development (R&D) in this area. In Hong Kong, our industries are exploiting the potential of commercial application of nanotechnology. Government needs to support applied R&D work in nanotechnology with a view to developing new nanotechnology-based industries and products in Hong Kong and enhancing our competitiveness.

PROPOSAL

2. The Commissioner for Innovation and Technology (CIT), with the support of the Secretary for Commerce, Industry and Technology, proposes to allocate $56,911,000 from the Innovation and Technology Fund (ITF) to support a project from the Hong Kong University of Science and Technology (HKUST) to develop functional nanomaterials and technologies through the establishment of the Institute of Nanomaterials and Nanotechnology (INMT).

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JUSTIFICATION

3. In Hong Kong, various types of nanoscience and nanotechnology research are carried out at the universities. The Government has provided a total of about HK$107 million in the past few years to support basic and applied research projects in this technology area through the Research Grants Council and the ITF. In response to the motion on "developing nanotechnology" carried by the Legislative Council on 31 October 2001, we issued a solicitation theme on nanotechnology under the Innovation and Technology Support Programme of the ITF and invited applications from the local research institutions in July 2002. Given the interdisciplinary nature of nanotechnology, the objectives of the solicitation theme are to create synergy, collaboration and greater impact through integration of individual efforts with a view to bringing techno-economic advancement in Hong Kong.

4. A Nanotechnology Projects Vetting Committee (NPVC) comprising both industrialists and international experts in the field of nanotechnology was set up to assist CIT in assessing the applications received. A list of the membership of the NPVC is at Enclosure 1.

Encl. 1

5. 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 applications from the Hong Kong Polytechnic University (PolyU) and HKUST should be supported. PolyU's project aims to improve properties of fabrics through the application of nano-finishing and nanotechnology. The amount requested from the ITF was $12.5 million. This amount has been charged to Subhead 101 Innovation and Technology (block vote), which has been created with Members' approval for ITF projects each costing at or less than $15 million.

6. HKUST's project aims to develop functional nanomaterials and technologies that have multiple applications and product potentials for adoption by the local industries. The project proposes to establish an INMT in partnership with industries for research, development and application of nanomaterials/devices that are relevant to the economic growth of Hong Kong. The Institute will also serve as a regional and international focal point for advances in nanotechnology R&D. The project involves a four-year R&D programme and its major near-term commercial applications and technologies include –

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(a) "Energy storage: Microfuel Cells". The eco-friendly microfuel cells with nanostructured materials and miniaturised architecture will enhance performance of portable electronic devices such as mobile phones and handheld personal digital assistants;

(b) "Nanoelectronics Displays". Tremendous demand for better performance and new applications has driven progressive advancement of display technologies. The application of nanotechnology will make important contributions to this evolution; and

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

Encl. 2 Technical details of the HKUST's project are at Enclosure 2.

7. After having visited the University and understood their research capabilities and the facilities available in the area of nanotechnology, the NPVC supported the HKUST's project for the following reasons -

(a) the HKUST has identified certain niche areas in which they can build on its strengths to create greater impact in nanotechnology for the region through the establishment of the INMT;

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

(c) the proposed INMT management structure in the project is effective and the project has demonstrated that it can facilitate collaborative efforts within/outside the institution and the industry for the research and development work; and

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

8. The NPVC concluded that the applications and technologies developed in each of the project areas would bring economic benefits through improvement of product performance and possibly create business opportunities to Hong Kong. In this connection, we note that the commercial applications to be derived from HKUST's nanotechnology platform are closely related to the strengths of Hong Kong industries, such as the electronics industries. Moreover, the project, if successfully completed, will put Hong Kong on the map of nanotechnology development.

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Control Mechanism

9. HKUST will be required to submit half-yearly progress reports to the NPVC describing the progress against its milestones stated in the project proposal. ITF grants will be disbursed by instalments, and the disbursement will be contingent upon acceptance of the progress report by the Committee. The Government has the right to terminate the funding of the project at any time if the project lacks progress in a material way or there is evidence that the chance of completing the project in accordance with the approved project proposal is low.

10. To ensure that the project funds have been fully and properly applied to the approved project, HKUST will be required to submit annual and final audited accounts audited by an independent auditor.

FINANCIAL IMPLICATIONS

11. The total cost estimate of the HKUST's project is $63,236,000. The HKUST has secured a total sponsorship amounting to $6,325,000 from the relevant industries, and the net amount requested from the ITF is $56,911,000. The budget of this four-year programme is broken down as follows –

		Estimated Cost $'000
(a)	Staff	35,930
(b)	Equipment	16,976
(c)	Other Direct Costs	10,330
	Sub-total	63,236
	Less Amount of sponsorship from relevant industries	6,325
	Total amount to be funded from the ITF	56,911

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12. As regards paragraph 11(a) above, the expenditure of $35,930,000 is for the salaries and Mandatory Provident Fund contribution for the Institute's staff. The Institute will be headed by a director who will be responsible for managing the Institute, industry liaison and technical transfer activities. He will be assisted by a technical manager who will be responsible for the integration and coordination of the various research activities. A total of 12 research associates, 17 research assistants, six technicians and one project assistant will also be employed to undertake the R&D work. NPVC considered the manpower costs for this research scale are reasonable.

13. As regards paragraph 11(b), the expenditure of $16,976,000 is for research equipment and pilot line facilities. While instrumentation needs will be supported through the existing research infrastructure of HKUST, new equipment will be acquired to build up the R&D infrastructure for the project. The new equipment is for nanomaterials synthesis, separations, purifications, characterization, fabrication of nanostructures and pilot lines for manufacturing.

14. As regards paragraph 11(c), the expenditure of $10,330,000 is for consumables and charges for analytical work and clean room facilities; chemicals and materials for various experiments, e.g. liquid crystals, silicon and glass wafers, photoresists, photomask, wafer cleaning materials, gases, substrates for OLED studies; testing set-ups, e.g. reaction chambers, meters for physical measurements, measuring probes, controllers; external consultancy fees, e.g. consultancy on the formation of various carbon materials; and promotional and publicity activities which aim to facilitate the technology transfer of the developed technologies.

Encl. 3 15. A detailed breakdown of the budget is at enclosure 3.

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16. The cashflow requirement of the project is as follows -

	2003-04 $'000	2004-05 $'000	2005-06 $'000	2006-07 $'000	Total $'000
(a) Staff	8,850	9,330	9,510	8,240	35,930
(b) Equipment	12,374	1,950	2,452	200	16,976
(c) Other direct costs	2,405	2,575	2,835	2,515	10,330
Sub-total	23,629	13,855	14,797	10,955	63,236
Less Sponsorship from relevant Industries [Note]	3,163	-	-	3,162	6,325
Total amount to be funded from ITF	20,466	13,855	14,797	7,793	56,911

17. HKUST has a business plan to ensure the continued operation of the Institute after the completion of the project. This includes membership fee from industrial consortium on nanotechnology, industrial R&D contracts, technology licensing fees, research funding from overseas and internal university research funds. The University expects to generate an annual income in the fifth year of the operation of about $12 million which would enable the Institute to continue its research and training programme in nanotechnology in future. The project duration for nanotechnology centers funded by National Science Foundation in the US is generally five years. Considering the need for expediting the research results for upgrading technology development in Hong Kong industry, the NPVC Members recommended to reduce the project duration from five years to four years.

18. Subject to Members' approval, we will meet the cost of the proposed project by offsetting an equivalent amount under Subhead 101 Innovation and Technology (block vote).

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Note According to the ITF funding policy, half of the sponsorship from the industries have to be received before project commencement and the remaining half before project completion. The cashflow for ITF is made on such assumption.

CONSULTATION WITH LEGISLATIVE COUNCIL PANEL

19. We consulted the Legislative Council Panel on Commerce and Industry on the proposal on 10 February 2003. The Panel supported the proposal.

BACKGROUND INFORMATION

20. The ITF was established on 30 June 1999 to finance projects to help promote innovation and technology upgrading in manufacturing and service industries with a view to enhancing Hong Kong's economic development. Members approved, on 9 July 1999 vide FCR(1999-2000)36, an appropriation of $5 billion to the ITF and the arrangement whereby the Financial Secretary has delegated authority to approve individual projects not exceeding the prevailing funding ceiling of a Category D project in the Public Works Programme (currently at $15 million). Projects exceeding the $15 million funding ceiling will require Members' approval under a separate individual subhead in Head 111 and the project cost will be offset by deleting an equivalent amount under Subhead 101 Innovation and Technology (block vote).

Commerce, Industry and Technology Bureau
April 2003

Enclosure 1 to FCR(2003-04)2

Membership List of the Nanotechnology Projects Vetting Committee

Chairman Permanent Secretary for Commerce, Industry and Technology (Information Technology and Broadcasting)

Members

Mr Daniel Cheng
Group Managing Director
Dunwell Industrial (Holdings) Ltd

Mr K O Chia
Managing Director
Walden International Hong Kong Ltd

Mr George Chung
Chairman
Standard Telecommunications Ltd

Dr Eric Lean
Advisor to Chairman
SAE Magnetics (HK) Ltd

Dr Harry N S Lee, SBS, JP
Managing Director
TAL Apparel Ltd

Dr York Liao, JP
Managing Director
Winbridge Co Ltd

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

Members (cont'd)

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

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

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

Technical Details of the Project Proposal from the Hong Kong University of Science and Technology

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 development of nanomaterials and nanotechnologies that have multiple applications and product potentials in partnership with industry, and other educational and research institutions. The NPVC decided not to fund the fourth area, i.e. Environmental catalysts, under this project as much of the R&D work has already been done. The four-year program comprises three core areas:

1. Energy storage: Microfuel cells based on ultra-small carbon nanotubes, fullerenes, nanoporous membranes and nanoparticles;
2. Nanoelectronics: Displays based on ultra-fine nanostructures made with organic and inorganic materials; and
3. Integrated manufacturing technologies for nanomaterials including CNTs and fullerenes, and nanoparticles including organic and inorganic compounds. Three existing nanotechnology projects – batteries (Energy Storage), transistors (Nanoelectronics) and catalysts (Environmental catalysts) – will be incorporated into the Institute management to maximise 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 commercialisation will be promoted by the Institute, thus leading to the development of new nanotechnology-based industries in Hong Kong and the Region.

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3. Objectives

To establish an INMT in partnership with industries, to be housed at the 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 –

(a) establishing the Institute as a world-class nanomaterials and nanotechnology R&D centre for technology development, technology transfer, industry partnership, and international collaboration;

(b) developing core competence in critical areas of nanomaterials and nanotechnology that can lead to potentially new commercial products and processes and enhance existing foundation industries in Hong Kong and the region;

(c) enhancing Hong Kong's human resources in nanotechnology (scientists, engineers and entrepreneurs) for the present and future needs of Hong Kong and the region; and

(d) acting as a regional and international focal point for nanomaterials and nanotechnology R&D through a multi-disciplinary 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. The approach is to have continuous interaction with 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 –

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Energy storage - Microfuel cells

(a) Inorganic proton transport membranes based on nanoporous zeolite and molecular sieve materials.

(b) 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.

(c) A 20% improvement in catalyst material for direct fuel conversion in microfuel cell device compared to PtRu (1:1) catalyst.

(d) Replacement of catalyst support and electrode materials using nano-carbon materials (e.g., carbon nanotubes (CNT), carbon nanohorns and fullerenes).

(e) 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.

(f) Establish microfabrication protocols to implement the microfuel cell design architecture that will enable the incorporation of new membrane, catalyst and electrode materials.

(g) Implementation of industrial standard, economical adaptation of microfuel cell unit to existing and emerging electronic devices for IT and communication applications.

(h) Manufacturing process specification and pilot plant design and feasibility evaluations.

Nanoelectronics: Displays

(a) 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 electrochromic format for application in cell phones based on nanoparticles.

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(b) Deliverable Two

An organic light emitting diode display with enhanced external coupling using nanostructured surfaces. We shall target at 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.

(c) Deliverable Three

An active matrix organic light emitting diode display using our nanoparticle induced low temperature polycrystalline silicon technology. We shall deliver a Quarter Video Graphics Array (QVGA) resolution (240x320), 3.5" diagonal display, with fully integrated internal drivers. We shall use micro-colour filters and make this a full colour display. This display can be useful for personal digital assistant 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 forfullerenes, and a similar order of magnitude for CNTs.

Enclosure 3 to FCR(2003-04)2

Proposed Budget for
the Institute of Nanomaterials and Nanotechnology

	2003-04 $'000	2004-05 $'000	2005-06 $'000	2006-07 $'000	Total $'000
Expenditure					
(I) Staff					
Sub-total (I):	8,850	9,330	9,510	8,240	35,930
(II) Equipment					
(a) Energy storage: Microfuel Cells	400	-	-	-	400
(b) Nanoelectronics: Displays	6,424	400	400	200	7,424
(c) Integrated Manufacturing	5,550	1,550	-	-	7,100
(d) Pilot line	-	-	2,052	-	2,052
Sub-total (II):	12,374	1,950	2,452	200	16,976

(III) Other direct costs					
Testing set-ups	620	650	790	640	2,700
Consumables and chemicals (e.g. solvents, liquid crystals, wafers and photoresists)	870	900	1,000	830	3,600
Others (promotional activities, attending conferences, external consultancy fees, audit fees, etc.)	915	1,025	1,045	1,045	4,030
Sub-total (III):	2,405	2,575	2,835	2,515	10,330
***Total Expenditure ((I)+(II)+(III))*:**	**23,629**	**13,855**	**14,797**	**10,955**	**63,236**
Income					
(a) Sponsorship from Industries	3,163	-	-	3,162	6,325
(b) Funds from the ITF	20,466	13,855	14,797	7,793	56,911
Total Income:	**23,629**	**13,855**	**14,797**	**10,955**	**63,236**