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Expert Group Meeting on
Processing and Application of
New Materials

Vienna, Austria, 4-6 November 1991

REPORT*

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Table of Contents

INTRODUCTION 3
CONCLUSIONS AND RECOMMENDATIONS 3
I. ORGANIZATION OF THE MEETING 6
II. SUMMARIES OF DISCUSSIONS 7
CLOSURE OF THE MEETING 11

ANNEXES 12
Annex I:
LIST OF PARTICIPANTS 12
Annex II:
AGENDA 15
Annex III:
DOCUMENTATION 16
Annex IV:
LIST OF PARTICIPANTS IN THE WORKING GROUPS 17

INTRODUCTION

The Expert Group Meeting on Application and Processing of New Materials was held at Vienna from 4 to 6 November 1991 to exchange views and to advise UNIDO on identifying a possible programme of action to enhance activities in the field of new materials in developing countries.

The raw materials necessary for new materials production are available in many developing countries. Among these are materials needed in electronics, energy source industries and consumer products. Application of new materials in industry and everyday life, such as for housing, medicine and pollution control can increase the effectiveness and reliability of devices based on these materials. They can also create new commercial possibilities and improve living standards.

The objectives of the meeting were:

- to exchange information on the potential of advanced materials and new applications of these materials for participants from developing countries;

- to discuss the possible role of UNIDO in the field of technical assistance to meet the needs of developing countries for the improvement of production facilities for new materials and products in areas of energy conservation, pollution control, as well as in other applications for local and export markets;

- to act as a forum for the exchange of information and experience among experts from developed and developing countries in the field of advanced materials, and to promote possible forms of cooperation between developed and developing countries themselves in this very important technology.

CONCLUSIONS AND RECOMMENDATIONS

General discussions at the plenary sessions resulted in the following conclusions:

There is a wide range of possible applications of new materials in developing countries, e.g. for photovoltaics (PVs) in rural electrification, medical refrigeration, pumping of water and telecommunication, for electronic materials, i.e. sensors for pollution control and health care, telecommunication systems based on optical fibres, pure materials for electronic and optoelectronic devices, and for ceramics (especially based on existing raw materials after beneficiation).

In the above-mentioned fields there is R & D activity in some developing countries. However, there are some considerable barriers and constraints preventing a successful application of new materials.

These are:

- Developing countries are not always aware of their potential in the field of new materials (application and commercialization); possibilities for application and production are not well known by a number of developing countries;

- Insufficient cooperation between developing and developed countries regarding preparation and application of new materials and technologies;

- Insufficient interaction between developing countries in this area and lack of information on possibilities of applications of new materials in developing countries themselves;

- Inadequately qualified manpower;

- Lack of suitable interaction among universities, R & D centres, industry and the market.

It was recommended that UNIDO should:

- Elaborate Awareness Development Programmes on new materials and provide assistance to developing countries aimed to introduce and highlight international trends (applied R&D, applications, training, information dissemination) and the national needs for new materials and technologies;

- Improve and strengthen the cooperation in this field between developed and developing countries;

- Establish a cooperation network in processing and application of new materials between developing countries in order to share experience, technologies and information in this field. To establish Centres of Excellence for new materials;

- Develop a training system for qualified manpower, using facilities of regional/international materials research societies. To organize workshops in specific areas of new materials (electronic, polymer, solar);

- Analyze markets, levels of industrialization, and the potential for a number of technical achievements of advanced materials institutes in some of the developing countries;

- Create plans for industrialization in the field of new materials in developing countries and organize workshops especially for countries where there is a lack of knowledge of new materials. Such work plans should include potential projects involving industry in order to attract investment in some form.

- Strengthen and enhance the technology base of existing and new companies and their products.

Electronic Materials, including Sensors

Working Group I recommended that:

- Member countries should undertake studies with UNIDO's assistance to identify potential areas for development based on well defined criteria. Priority should be given to regional studies.

- UNIDO should organize workshops to discuss the potential areas identified, describe activities and assess the inputs required to achieve the desired results.

- UNIDO should assist the concerned countries to carry out further studies, as required, to identify possibilities of new materials application, availability of raw materials and an appropriate infrastructure and assist in formulating and implementing the appropriate projects by providing the required technical assistance.

- UNIDO should assist in identifying financial resources. Activities to be taken up for the development of new materials production could include:

- Transfer of technology
- Seminars, workshops, study tours
- Training
- Consultancy

- UNIDO should hold Expert Group Meetings each year at different locations to deal with regional/specific problems.

Specific projects:

The Working Group identified specific projects for UNIDO's assistance and suggested that detailed proposals are presented by countries through their respective Governments.

These include:

- Study on regional cooperation in the area of new materials: (e. g. PARADIGMA PROJECT, Brazil: This project is in the process of implementation as part of the work programme of the Latin American Integration Association aimed to enhance the region's capacities for designing, manufacturing and marketing integrated circuits and other electronic devices).

- Seminars to be organized by UNIDO on Advanced Materials and Technologies as follows:

- USSR	- 1992	(general - awareness and policy-making strategies)
- Hungary	- 1992	(specific - thin films for microelectronics)
- India	- 1993	(general - project formulation and planning/ specific - technology of microelectronic materials).

- Study tour to be organized by UNIDO (e.g. to Taiwan's Electronics Industry, Taiwan Province).

- Study to be organized by UNIDO on information systems, marketing and availability of materials technology for developing countries (e.g. in Brazil and the Republic of Korea).

- Regional centres/projects to be set up with the help of UNIDO in developing countries where the electronic materials technology has been developed, including industrial technology.

- Information database on new materials and relevant studies by regional centres.

- Mode of assistance to strengthen R & D laboratories in countries where very limited activities are carried out (e.g. in Ghana).

- Specific project on sensor materials (e.g. joint project in Taiwan Province, Hungary, USSR, Brazil, and India).

- A network of Centres of Excellence to meet the needs of developing countries with assistance from UNIDO: countries should prepare specific proposals in their areas of expertise especially where an infrastructure already exists.

- Technology Park (Brazil): This project will support a Latin American Programme, presently under development, devoted to the study and to the setting up of high-technology companies and technology parks as a way to enhance the linkage between R & D and industries in the region.

Solar Materials

Working Group II identified several areas for technical assistance and cooperation, as follows:

- Provide assistance to assess needs of different countries, especially with respect to appropriate technologies for various applications and feasibility of technology transfer or research cooperation, need of systems/production technology, etc;

- Educate consumers through workshops and technical meetings to make a judicious choice of technology, supplies, maintenance and "real" costs of various energy sources;

- Provide means for system certification through a central entity;

- Set up an information database on new materials in each country;

- Provide technical assistance for R & D, specifically for process technology/equipment;

- Establish joint ventures for manufacturing of PV systems, devices and materials;

- Research cooperation is required for specific problems related to technologies and for setting up a pilot production line in some countries that have R & D laboratories;

- Assist in arranging agreements and licences for manufacturing and joint ventures. The licensor should protect the technology.

Ceramic Materials

Working Group III recommended that:

- Efforts for improvement of the quality of products and production technology of existing traditional technology should be intensified;

- Strengthen "national" R & D laboratory organizations that deal with problems of planning and information generation bases for local industry, e.g. Mubarak City Technology Park, Egypt; Newstetten, Production of Documentaries, Nigeria; Center for Nuclear Science Techniques, University of Nairobi, Kenya.

- Survey of demand and supply of required raw materials should be carried out, e.g. in Egypt, Kenya and Brazil;

- Possibility of ceramics production based on the available raw materials and the local market should be analyzed;

- Start-up of an industrial activity in advanced materials in the countries which have an established ceramic industry, a well equipped advanced materials institute and a growing need for material products, e.g. electroceramics for electronics in Brazil, Egypt and Venezuela;

- Training of ceramists through workshops and specialized programmes should be provided to generate adequately qualified manpower, e.g. Brazil, India, Indonesia, Kenya and Nigeria.

I. ORGANIZATION OF THE MEETING

The meeting was formally opened by the Director of the Industrial Operations Technology Division. She welcomed participants of the Expert Group Meeting on behalf of the Director-General. She pointed out the importance of the new materials area for developing countries and emphasized that developing countries should intensify their efforts in industrialization in this field of activity. Participants should, therefore, find ways to meet the needs of their countries in the field of new materials and identify UNIDO's assistance in this area.

The meeting was attended by 14 experts of the following countries:
Oluremi Aribisala (Nigeria), René Asomoza (Mexico), Mohamed Mokhtar El-Halwagi (Egypt), Anthony Mawuko Goka (Ghana), Tu Hailing (China), Hamdan Mokhtar (Malaysia), Kefa Muga (Kenya), S. G. Patil (India), Purnomo Pranggono (Indonesia), Roberto Spolidoro (Brazil), Vicente Tortoriello (Venezuela), Peter Batchelor (United States of America), Valeri Kravtchenko (Union of Soviet Socialist Republics) and Bhushan Sopori (United States of America).

Observers from the following Member States also attended the meeting: Austria, Brazil, Hungary, the Netherlands, the Republic of Korea and the Union of Soviet Socialist Republics. An observer from Taiwan Province also attended the meeting and presented a paper.
The International Atomic Energy Agency was represented by two observers:
Ms. Irene Lewkowicz and Mr. Valco Valkovic. A list of participants is in annex I.

The following officers of the Plenary Session were elected:

Chairman: P. Bongers (the Netherlands)
Rapporteur: S. G. Patil (India)

The meeting established working groups to discuss and prepare recommendations. Taking into account that there were three main groups of materials presented it was decided to divide participants into the following working groups:

Working Group I dealt with Electronic Materials including Sensors. Working Group II dealt with Solar Materials. Working Group III dealt with Ceramic Materials.

The following officers were elected:

Working Group I:
Chairman: G.-C. Chi (Taiwan Province)
Rapporteur: S. G. Patil (India)

Working Group II:
Chairman: B. L. Sopori (United States of America)
Rapporteur: R. Asomoza (Mexico)

Working Group III:
Chairman: V. Tortoriello (Venezuela)
Rapporteur: P. Pranggono (Indonesia)

The agenda as in annex II was adopted.

The documentation available to participants at the Meeting is presented in annex III.

The report was adopted on 6 November 1991.

II. SUMMARIES OF DISCUSSIONS

At the Plenary Session the scope of UNIDO's technical assistance was presented by Industrial Development Officer of the Industrial Technologies Support Unit. Other presentations giving UNIDO's activities in the field of advanced materials were made by the Chief of Non-Metallic Minerals, Ceramics, Glass and Building Materials Unit. He reported on ceramics and included mention of the Expert Group Meeting on Advanced Ceramics held at Ankara, Turkey, October 1990. He made available to participants the report of that meeting. The Chief of Iron and Steel and New Processes Unit also described UNIDO's activities in the field of advanced materials including rare earths and alloys. Three invited experts also made presentations in their specific areas as given below.

B. Sopori (United States of America) discussed the present situation in the field of PVs with respect to the potential growth which is still considerable. The advantage of PVs is that they are a non-polluting source of energy. The demand for PVs is expected to be nearly 600 GW worldwide between now and year 2000. He pointed out that PVs representing a unique source of energy could be a viable option for rural areas in developing countries. The cost of PV energy can be lowered. Most of the development work has been carried out in advanced countries (United States of America, Japan, Europe) and the reduction of costs has been substantial in the last 20 years. High efficiency solar cells were obtained on GaAs and Si materials and in the area of thin films, amorphous silicon, CdTe and $CuInSe_2$.

Advantages and disadvantages of various materials in terms of conversion efficiency and cost comparison of materials were presented, and the status of development on each of the important materials was reviewed. He highlighted the strength of each material and the gaps which should be bridged to meet efficiency and price criteria.

During the discussion, several suggestions were made regarding processing and application of these materials for developing countries. The main points emphasized were:

- PV system efficiency is lower than those at solar cells level;

- Though thin film technologies are promising in the production of PVs, technological development is needed for improvement, for example for degradation in amorphous silicon solar cells;

- Some commercial applications in consumer electronics are an up and coming technology;

- Power generation through PVs was found feasible for remote area applications with subsidies from the Government and industry.

V. Kravtchenko (Union of Soviet Socialist Republics) defined sensors as devices which provide knowledge to the external world. These sensors are used for a variety of applications. He estimated the world market to be about US$45 billion including electronic sensors of US$15 billion. A variety of types of sensors are used in industry, medicine and pollution control. Major production and development work is carried out in Europe, Japan and the United States. He described various materials used for conversion of different types of signals in the form of the metrics of devices and associated technologies. He highlighted the importance of sensors in the area of industrial pollution. "Smart" sensors as a future direction of development would generate a large growth for a variety of sensor materials.

During the discussion several suggestions were made regarding processing and application of these materials for developing countries and the main points emphasized were:

a) importance of some materials for various applications, such as ceramics doped by rare earth oxides;

b) step-by-step development of electronic systems;

c) need to identify applications for practical use.

P. Batchelor (United States of America) defined the traditional ceramics industry as a clay-based industry and stated that the industry is common both in developing and developed countries. While highlighting issues related to technology transfer on the basis of his experience with developing countries, he emphasized the importance of tailoring the technology to use basic raw materials which are available locally. That is necessary to gain maximum economic benefits. He also mentioned other important issues, including factors complicating the development and application of ceramic materials in developing countries.

During the discussion the importance of transferring technology, including not only supply of equipment, but also high level expertise and training of skilled manpower, was highlighted and the importance of ceramic materials for developing countries was emphasized.

Summaries of working group discussions

Members of the working groups made presentations and discussed various issues relevant to the field covering the present status, applications, demand, barriers and constraints. A list of participants in the working groups is in annex IV.

Working Group I - Electronic Materials including Sensors

Potential demand and applications - Review of present situation

The Members of the Working Group made several observations on the status and demand of electronic materials. Generally there seemed to be difficulties in defining electronic materials. However, for the purpose of the discussion electronic materials were defined to be those materials exclusive for electronic devices. These include, in addition to Si, GaAs, other semiconductor materials, such as electronic, ceramic, optoelectronic materials, photolithographic materials, and optical fibre. The working group also deliberated on sensor materials.

Constraints and barriers

The observations made include the following main points:

- Except for a few member countries the production of electronics, especially components, is small in developing countries and, therefore, in many cases the local demand is not sufficient to set up commercial production.

- Electronic materials are basically characterized by small volume and highly priced items. The value addition from processing of basic materials or the technology is high. Generally the appropriate technology is either not available from developed countries, or the price is high, or the process is covered by patents. Some developing countries cannot afford to pay this high price, as the volume of production is relatively low.

- In a few cases the transferred technology does not necessarily produce the material at the required quality and price level. Tailoring of technology to specific needs has to be carried out by the concerned developing countries which may or may not have expertise.

- Development of electronic materials within a country may be time consuming and may not be a cost effective solution in some cases, unless exports are envisaged. Therefore, a solution has to be found.

- The process equipment and characterization facilities are expensive and also generally not available for developing countries.

- Limited attempts are being made to develop interaction among developing countries.

Working Group II - Solar Photovoltaic Materials

Review of the present situation

The discussions highlighted the relevant issues including energy needs in each country and state-of-the-art of PV technology. It was observed that PVs can meet most of the energy needs of developing countries. There is considerable demand for energy sources, such as PVs in developing countries. In Mexico, for example, 11 million people have no electricity in 85,000 rural communities as they are not in the vicinity of electrical grids. In China, 200 million people do not have adequate electric supplies. In Malaysia 5% of the homes have no electrical power.

The major applications of PVs include rural electrification, medical refrigeration, pumping of water, telecommunications and in some countries for conservation of environment and peak load purposes.

In many countries considerable potential demand exists if costs could be brought down. For example, China has a requirement of 100 MW/a and of this 5 to 10 MW/a is needed for lighting, TV and electric appliances. Mexico is also in a similar situation and they have planned to install 10,000 systems per year under the national Electrification Project. Malaysia has a demand of 1 MW/a mostly for pumping of water and at the National Department for their installations of exploratory systems.

Constraints and barriers

Though considerable potential exists for the growth of PVs there are a number of constraints and barriers. They include mainly:

- Large initial investment for PV system installations though operation costs are low and the technology is environmentally friendly;

- Consumers are not exposed to PV technology with regard to the operation;

- Technological development can be expensive and time consuming in many cases and solutions have to be found;

- In the field of PVs there is a lack of marketing and distribution network in developing countries;

- There are many materials technologies on the horizon but there is a need to educate buyers to make correct choices;

- System certification facilities are not available.

Working Group III - Ceramic Materials

Review of the present situation with regard to the demand and applications

In addition to the presentations the Working Group also took note of the report of the Expert Group Meeting on Advanced Ceramics organized by UNIDO held at Ankara, Turkey, from 1 to 6 October 1990. That report covers some of the issues regarding applications and demand. Therefore, the Working Group concentrated on discussing constraints and barriers.

Constraints and barriers

Developing countries have various degrees of constraints and barriers for industrialization. Observations made include the following main points:

a) Lack of human resources including adequately qualified specialists in industry, as well as research;

b) Lack of adequate infrastructure specifically for industrial production, R & D, as well as basic education in the ceramics area;

c) Lack of up-to-date information on resources, market potential, advanced technology sources necessary for effective planning and implementation;

d) Inadequate facilities, sophisticated testing and characterization equipment for raw materials and products in some countries;

e) Lack of appropriate linkage between R & D and industry in countries where some infrastructure and expertise have been established.

CLOSURE OF THE MEETING

The Chairman summarized the Meeting by stating that ideas were put forward in an optimistic and positive form and noted that needs and directions for future programmes had been identified and that the objectives of the meeting had been fulfilled. He emphasized the need for programmes resulting in improved industrialization in developing countries rather than developing research capabilities. He expressed the hope that all developing countries, especially those who have taken initiative, could benefit as a result of such an exercise. In light of the continuity of this exercise, he suggested that the Experts could make suggestions to the UNIDO Secretariat regarding the discussion and follow-up work on the recommendations put forward by the Meeting. The Rapporteur expressed his special appreciation to UNIDO for taking timely initiative in the organization of such a Meeting on a subject which is important to developing countries. He expressed the hope that UNIDO will continue its efforts in this area and organize similar meetings/workshops in the future.

On behalf of UNIDO's Secretariat, the Head of Industrial Technologies Support Unit thanked participants for their valuable contribution to helping UNIDO identify a future course of action in providing technical assistance to developing countries in industrialization in the field of new materials.

Annex I

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Annex II

AGENDA

1. Opening of the Meeting.

2. Election of officers (Chairman, leaders of working groups and Rapporteurs).

3. Adoption of the Agenda.

4. Plenary Meeting.

5. Meeting of Working Groups. Working Group I: Electronic Materials including sensors

   Working Group II: Solar Materials

   Working Group III: Ceramic Materials

6. Closing Session: report of the Working Groups.

7. General discussion and adoption of the report.

Annex III

DOCUMENTATION

Document no.	Title	Author
ID/WG.519/6 (SPEC.)	Processing and Application of Advanced Materials - Case study: Nigeria	O. A. Aribisala
ID/WG.519/8 (SPEC.)	Status of Research and Development Activities in Mexico Related to Photovoltaic Applications	R. Asomoza
ID/WG.519/13 (SPEC.)	Development and Projection of Alumina Fibres from Natural Resource-Base Materials (Clay/Bauxite): Development and Production	A. M. Goka
ID/WG.519/11 (SPEC.)	New and Advanced Materials: The Egyptian Case	M. M. El-Halwagi
ID/WG.519/10 (SPEC.)	Recent Progress and Future Plans for Amorphous Silicon Solar Cells in China	T. Hailing
ID/WG.519/4 (SPEC.)	Potential of Processing and Application of New Materials for Energy and Heat Generation in Malaysia	H. Mokhtar
ID/WG.519/12 (SPEC.)	Processing and Application of Advanced Materials in Kenya - Emphasis on Ceramic and Solar Energy	K. Muga
ID/WG.519/3 (SPEC.)	Development of Electronic Materials in India: Status and Proposals for Co-operation	S. G. Patil
-	Utilization of Silicon Carbide from Rice Hull	F. Pranggono
ID/WG.519/5 (SPEC.)	The Knowledge Society and the Latin American Countries Community	R. M. Spolidoro
ID/WG.519/1 (SPEC.)	Advanced Materials in Venezuela	V. Tortoriello and Y. Gonzalez
-	Advanced Materials - Ceramics	P. Batchelor
ID/WG.519/2 (SPEC.)	Sensor Materials for Pollution Control and Other Applications	V. Kravtchenko
ID/WG.519/7 (SPEC.)	Photovoltaic Solar Energy Devices: Materials Research and Applications	B. L. Sopori
-	Structure-Research and Education - A Basis for Processing and Application of New Materials	P. B. Barna
-	Advanced Materials in Taiwan - Awareness, Constraints, Barriers, and International Cooperation	G.-C. Chi
-	Advanced Materials in the USSR: Proposals for International Cooperation and Meeting on Advanced Materials in the USSR in 1992	E. Sharipov

Annex IV

List of Participants in the

WORKING GROUPS

Working Group I - Electronic Materials, including Sensor Materials

Chairman: Mr. G.-C. Chi, Taiwan

Rapporteur: Mr. S. G. Patil, India

Mr. A. M. Goka, Ghana
Mr. P. B. Barna, Hungary
Mr. W. Fallmann, Austria
Mr. J. J. Kim, Rep. of Korea
Mr. V. Kravtchenko, USSR
Mr. E. Sharipov, USSR
Mr. R. M. Spolidoro, Brazil
Mr. V. Valkovic, IAEA

Working Group II - Solar Materials

Chairman: Mr. B. L. Sopori, USA

Rapporteur: Mr. R. Asomoza, Mexico

Mr. C. Bodwell, UNIDO
Mr. A. Bromley, UNIDO
Mr. T. Hailing, China
Mr. H. Mokhtar, Malaysia
Mr. M. Nogueira da Silva, UNIDO
Mr. G. Stangl, Austria

Working Group III - Ceramic Materials

Chairman: Mr. V. Tortoriello, Venezuela

Rapporteur: Mr. P. Pranggono, Indonesia

Ms. A. O. . .ibisala, Nigeria
Mr. N. Biering, UNIDO
Mr. P. F. Bongers, the Netherlands
Mr. M. M. El-Halwagi, Egypt
Mr. Y. Grebtsov, UNIDO
Mr. M. Montenegro, Brazil
Ms. I. Lewkowicz, IAEA.