Hopes are raised. Better times ahead for the community of scientists and technologists?

Every year at the Indian Science Congress the speech of the Prime Minister of India is eagerly awaited. This year, the Prime Minister Atal Bihari Vajpayee's speech at the 89th Indian Science Congress at Lucknow University, held during 3–7 January 2002 has raised hopes of the scientific community and shown the directions in which we are likely to move in the future.

Here are some excerpts from the Prime Minister's speech:

Science and Technology (S&T) is a critical input for India's all-round development. India's S&T capabilities have brought important intangible benefits to our nation. These capabilities give Indians a high degree of self-confidence. Vajpayee spoke of a greater role being played by scientists and technologists in policy making. He appealed to the S&T community for help in combating the terrorists who are 'trying to master advances in S&T to pose new threats to the civilized world'. We have resolved to fight terrorism to the finish, Vajpayee stated. He appealed to the S&T community of scientists, technologists and academics in countries of South Asia to join hands to fight terrorism and extremism. Also, he called upon them to collaborate in helping war-ravaged Afghanistan in its reconstruction efforts.

Vajpayee described the other challenges and tasks before the scientific community in two broad areas – higher education and R&D. Saying investment in R&D is an investment in India's future, he said at the Pune Science Congress, two years ago, 'I had announced that the Government would try to increase the ratio of total national R&D investments to GDP to around 1% by the end of the 9th Plan. I had also indicated we would go further and seek to increase the above ratio to 2% in the last year of the 10th Plan. I assure you that, in spite of constraints, we shall steadily move ahead to meet this target'.

He further added that the bulk of the incremental R&D investment should go to areas such as meteorology, oceanography, ecological recovery and environmental protection, disaster prevention and management, renewable energy and energy efficiency, new and more effective medicines for both the prevention and treatment of communicable diseases endemic in many parts of the country and conservation and sustainable utilization of our rich biodiversity. 'These were all important and promising sectors, which had not received enough attention so far,' he added.

On investments in the areas of agriculture, agricultural infrastructure and agricultural research, he said 'it was a matter of concern that, over much of the last decade, public investment had declined'. The Prime Minister noted that we need to step up our R&D efforts in achieving higher yields both on arid and irrigated lands, pest resistance, water and soil conservation, saving in use of fertilizers and prevention of loss and wastage. Attention would also be given to 'making our Eastern and North-Eastern States the new food baskets of India'. He said that he would ensure that plan outlays for agricultural research in the 10th Plan are large enough in order that agricultural production systems could 'return to their high growth path'.

With regard to biotechnology, Vajpayee said what we need is 'responsible biotechnology' which does not expose our ecology and society to major risks. He also said 'we need a "responsive" regulatory and enforcement mechanism' and stressed that we must also take care that 'the benefits of biotechnology reach all our people quickly'. Who will do research on using new biotechnological tools for dryland crops such as millets? It is we in India who need to take up this challenge, he reiterated.

'We must make every R&D rupee yield more.' There is a view, he said, that there is insufficient inter-agency and inter-laboratory communication, coordination and collaboration. 'This shortcoming should be removed.' He also stated that he was aware of a large number of organizational and administrative hurdles in the Government, which prevent optimal use of public R&D resources. 'Bureaucratism is an enemy of a result-oriented approach, and must be shunned, for it demotivates our scientific talent and compels our best professionals to spend their time and energy on unproductive matters.'

Vajpayee said he had called upon the Principal Scientific Adviser to the Government, R. Chidambaram and the Scientific Advisory Committee to the Cabinet (SAC-C) 'to undertake a comprehensive study of such problems and come up with changes in policies, practices, and procedures which will create a liberal, flexible, and motivating environment for R&D, not only in our Government agencies but also in our academic institutions'. 'I assure you that the Government would consider their recommendations with utmost seriousness', he added.

Speaking of the role of the private sector, he said 'the latest figures of R&D investments by industry continue to be dismal'. Quoting figures he stated that 'the R&D expenditure of a significant part of large-scale industry is currently running at no more than 0.7% of sales. The pharmaceutical industry alone has shown significant improvement in this regard over the nineties, with their R&D to sales ratio currently running at around 2%.

In order to raise the levels of S&T spending, he said that Indian industry must, in its own interest, start to contribute its due share. In countries such as the United States of America, 80% of the scientists are employed in private industry. 'Our proportion is just the reverse'. He felt a strong need to build public–private partnerships, 'by which the resources of Government R&D establishments, including where necessary, our Universities, are directly and profitably harnessed for industrial R&D'.

Vajpayee said, 'given the enormous pool of scientific talent in the country, policies need to be developed for attracting Indian private, as well as foreign direct investment in the R&D sector, so that R&D services comprise a growing proportion of India's expanding and globalizing service sector'. He called for the S&T community for working, in particular, with the Ministry of External Affairs to 'increase awareness to the rest of the world about the availability of India's scientific capacity'.

He admitted that R&D in our University system is not receiving as much attention as in specialized agencies and laboratories. 'Creative universities are

the bedrock of every developed nation's S&T strategy', he said, adding that, 'it is a matter of concern that science departments in India's vast university system have suffered greatly due to lack of investments, both in materials and in terms of faculty'. For reversing this, he suggested encouraging collaboration between the universities and local private industries. If necessary, this can be supported by seed money from the Government. About the alarming decline in the number of talented young students opting for science as a career, he emphasized that 'we should lose no time in addressing the many complex issues of higher education in India'.

Vajpayee stated that one of the most neglected areas of our S&T strategy is 'increasing and enriching the inputs of S&T knowledge in the vast informal and unorganized sector of our economy'. He said that there was a 'big need and an equally big scope to appropriately take the fruits of the formal S&T establishment to our carpenters and vegetable vendors, to our electricians and construction workers. When this happens, India will see a dramatic surge in quality, productivity, and efficiency in every area of our economy'. 'We must take science to the people.' Quoting Pandit Jawaharlal Nehru: 'Scientists are a minority in league with the future,' he reiterated that 'a bright future can be realized only when science is in league with the majority of our society'.

Vajpayee hoped that the thoughts and concerns he had expressed would be 'spelt out in sharper detail in the new National S&T Policy document' that is in the final stages of preparation.

Nirupa Sen

Keeping Indians healthy: Some issues

'Health Care' was one of three themes at the recently concluded Indian National Science Congress in Lucknow. The other two themes were Education and Information Technology. The desire for good health has been a goal since time immemorial, with society constantly striving towards it.

In an evening lecture, 'Health: The Goal Forever' M. S. Valiathan (Manipal Academy of Health Education (MAHE), Manipal) spoke of the importance of 'well-being'. This he put ahead of 'freedom from illness'. All ancient civilizations had laid emphasis on the necessity for preventive care. An ancient Indian greeting when translated from Sanskrit reads 'May all be well with you'. This shows the importance attached to health, said Valiathan. A great deal had been achieved in the last fifty years; however, everybody is dissatisfied with the health care system and there were several complaints.

Valiathan categorized the ills of the system as having 'three diseases'. The first, was the problem of access. Due to the paucity of infrastructure at the primary and secondary health centres, people had no option but to flock to tertiary facilities, such as large hospitals. The solution for this was not by raising allocations for health care or by transferring health care to Panchayati Institutions. More than this was needed. India had to attack the problem 'head-on' with a new approach. He suggested that patients must pay for items like gauze, dressing, etc. and a good insurance system should be put in place. Primary health centres that presently lay emphasis on family planning should also focus on alleviating common illnesses which constitute 90% of the needs in health care, he added.

The second problem was that of quality. Valiathan said there was a lack of quality in medical education and hospital care. He stressed that quality must improve. For this, accreditation and internationally accepted standards must be laid down for health care in the country. The third disease was lack of 'innovation'. Health care depended on instrumentation, technology and biotechnology products. India is presently importing 90% of these requirements. He cautioned that in the future 'medical procedures' could be patented and he wondered where it would leave us. There was a need for tremendous innovation in view of WTO and IPR regimes. He said innovation had been accomplished in the past, citing examples such as the Green Revolution, White Revolution and Missile Technology development. Danger was staring in our face in the area of health care. There was a perceived necessity for the innovative spirit to be activated in health care-related areas, he added. Above all, having self-confidence was of the essence. Citing a story of how a tiger cub was raised amidst the sheep and therefore lost its identity, he said, 'many of us are bleating tigers, we need to recognize ourselves now'.

In the plenary session, 'Health Care: Reaching the Unreached' N. K. Ganguly (ICMR) pointed out there was a great divide between advances in science and technology and health care. He emphasized that advances made in areas such as molecular biology etc. had not reached the health care system in the country. He said there was need for health sector reform on a massive scale. He hoped that the proposed new S&T policy document would link S&T to the social sector, or else, he cautioned 'we will not reach the target'.

B. M. Hegde (MAHE, Manipal) in his talk 'Health Care vs Medical Care' said that emergency medicine constituted only 10% of the sick population. Only this needs modern hi-tech medical and surgical care. 'Rest of them could make do with conventional traditional systems of medicine coupled with "changes in the life style"'. He drew attention to basic problems such as lack of toilets in rural areas and of sanitation in cities. There was a necessity to empower people, especially the women and explain the need for nutrition, toilets and clean drinking water through a comprehensive village development plan.

In his talk, 'Primary Health Care in India: Will Information Technology (IT) really make a difference', R. D. Lele (Jaslok Hospital, Mumbai) explained the role of a hospital as a 'Health Maintenance Organization'. In this concept the hospital would provide health check-ups and health-related advice to subscribers ranging from antenatal care to various health conditions. The family as a whole would be treated and their medical records of allergies and past illnesses main-

tained. This family approach would help in identifying risk factors for a young child to future diseases like diabetes and hypertension and lifestyle modification could begin even at an early age. He said if we were proactive we could transform policy to a reality with the help of IT.

K. Kasturirangan (Department of Space) spoke of 'Education and Health Care: Bridging the Access Divide' and the use of space technology as a tool for bridging this divide. He said the Indian innovation of exploiting the vantage point of space for social upliftment, empowerment of the rural population, developmental communication, training the trainers, among many others draws no parallel. Kasturirangan said that space offers the plausibility of transferring patient records, medical images and laboratory results through reliable voice and data links enabled by VSAT technology. This would ensure linking the islands of medical skill with the vast mainland of needs. Successful pilot projects have been undertaken already in some states such as Tamil Nadu, Karnataka, West Bengal and Tripura. The health care net, he said, would be expanded to Leh, Andaman and the North-East. In an experiment in Jhabua, Madhya Pradesh – a mainly tribal belt – programmes were beamed on health, watershed development and role of women, etc. to about 150 hamlets. The success of this experiment has now been expanded to two adjoining villages around Jhabua and similar efforts are being made in Gujarat. The GRAMSAT satellite would cater to such developmental needs, he added.

N. H. Antia (Foundation for Research in Community Health, Mumbai) gave insights into decentralized health care for the 'peoples sector in health and medical care'. Health in the 'Peoples Health Sector' is primarily a function of the individual, family and the local community. An Indian Council for Social Science Research (ICSSR)/Indian Council for Medical Research (ICMR) Report (1981) titled 'Health for All – An alternative strategy' (prepared under the chairmanship of V. Ramalingaswami) provided for a 'more holistic concept of both health as well as medical care', felt Antia. Medical aspects were graded either as those requiring social skills or technology. The report stated that 70% of all health care could be undertaken by e.g. a female village health functionary covering 200 people. Another 15% of health care problems could be attended by local female paramedical workers (Sahyoginis) trained for two years and each could help about 5000 people. At the taluka/block level, 95% of all health could be treated with the help of a 40-bed people's hospital having good infrastructure that could cater to 100,000 population. And the same hospital, together with a 'dharmashala' could provide medical (including surgical) facilities that would further extend the size of the facilities. Only 5% would require super-speciality skills and facilities at the district or city level.

According to Antia, despite a national expenditure of over Rs 80,000 crores in the public and private 'health' sectors, which is equivalent to 5% of our GDP, more than half of our people do not have access to even basic health or medical care. The public sector has to provide medical services to the entire population and is plagued by problems of funding etc. It is based mostly on the western model with only 4% of its budget provided to the Indian Systems of Medicine and Homeopathy, added Antia. On the other hand, he felt the private sector which now accounts for three quarters of the national health expenditure is almost entirely curative and hence profit-oriented. Even the poorest are now expending 20% of their meagre household expenditure on such services under duress of pain and suffering, and is only next to dowry as the cause of rural indebtedness. This is the result of the failure of the public sector, he added.

Antia cited several advantages of a community's own health care system which are closely interrelated with the development of Panchayati Raj. He added, as it may take over a decade for the Panchayati Raj to operate effectively on a countrywide scale, various methods for implementing the broad strategies of the Community Health Care System will have to be evolved in the interim period depending on local socio-economic, cultural, epidemiological and geographic conditions.

With the Health Policy of the Government of India in the making, it is hoped that some of these issues could be seriously considered and proper steps taken on a war footing for their implementation. Health care could only then become a reality for several of the 'unreached' in our villages, towns and cities.

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Whither electric vehicles?

Electricity is the natural medium for the application of motive power. Its supply is unlimited. It is everywhere. It is to movement what the sun is to growth.

– *Western Electrician*, January 1889

In the late 1890s, at the dawn of the automobile era, steam, gasoline and electric vehicles all competed to become the dominant automobile technology. By the early 1900s, the battle was over and Internal Combustion Engine Vehicles (ICEVs) were poised to become the prime movers of the twentieth century.

At present, about 60 million ICEVs are manufactured every year worldwide and it is projected that there would be about one billion ICEVs on the earth's roads by 2002, i.e. one for every seven people. This upsurge in the use of ICEVs is causing considerable pollution problems in our urban conurbations. In response to the growing concerns over the urban air quality, the state of California enacted in 1994, a legislation requiring that by 1998, 2% of cars offered for sale be zero-emission, increasing to 5% by 2000 and ultimately 10% by 2003. These deadlines however have been amended, largely because of the failure of battery-powered vehicles, which were originally seen as a solution, to perform at a level approaching that of the existing ICEVs. However, pure battery-powered vehicles are no longer regarded as an acceptable alternative to ICEVs, except possibly as Neighbourhood Electric Vehicles (NEVs) which are designed to provide low-speed

transportation in restricted areas such as university campuses, hospitals, airports, theme parks, industrial parks, holiday resorts, residential complexes and city centres.

The above situation does not imply that there are no legitimate uses of pure battery-powered electric cars today as fleet vehicles, as community cars and as second cars for families that already own a gasoline automobile for long-distance travel. One solution to this enigma might be to take the pure battery-powered electric cars out of the development laboratories and put them in the hands of the real drivers. Some will find these vehicles inadequate, but many others may not. With this proposition in mind, Saturn, in partnership with General Motors Advanced Technology Vehicles, now offers GEN II EV1 to consumers through a lease-only programme. Select Saturn retail facilities in California and Arizona distribute and service EV1. Saturn believes that this is the best way to ensure total customer enthusiasm for the early customers in their vehicle. Leasing will provide the customers with a known, consistent cost of ownership. Saturn covers all routine maintenance and service under the terms of 3-year/36000-miles new-vehicle limited warranty. This includes everything from batteries to tyres. Saturn also provides a 24-hour roadside assistance programme, to make every aspect of EV1 lease trouble-free.

While the fate of pure battery-powered electric cars hangs in limbo, the last five years has seen a dramatic development in fuel cells which have advanced to the point where manufacturers believe that the technology is commercially viable and capable of delivering sufficient energy for running the cars. Among various types of fuel cells, the low-operating temperature and rapid start-up characteristics, together with its robust solid-state construction give the Polymer Electrolyte Fuel Cells (PEFCs) a clear advantage for application in cars. The energy conversion efficiency of PEFCs is much higher than both Otto and Diesel versions of internal combustion engines.

The preferred fuel for PEFCs is hydrogen. Various strategies for providing hydrogen to PEFCs are presently being evaluated. Broadly speaking, these strategies could be divided into two categories: (a) to generate hydrogen on-board and on-demand from liquid hydrocarbon or methanol, and (b) to directly fuel hydrogen from a storage tank containing compressed/liquid hydrogen. Experts believe that for Fuel Cell Vehicles (FCVs) with an on-board fuel processor, it would be difficult to exceed the performance of the future ICEVs in terms of emission, efficiency, drivability, maintenance and first cost. By contrast, if the FCVs are powered by a directly-fuelled fuel cell, then there is every prospect that the performance of such vehicles will exceed that of the ICEVs, but not the first cost. However, given the recent rate of progress in PEFC technology, we expect a significant reduction in the cost of directly-fuelled fuel cells.

For direct-hydrogen FCVs, the main task is to develop a cost-effective, reliable and safe method of storing sufficient hydrogen on-board. Particularly, with buses, where there is more room for storage of hydrogen as a compressed gas, there are good prospects that commercial fuel-cell powered versions will be on the roads within 2 to 3 years. Such vehicles are centrally refuelled and therefore hydrogen-distribution infrastructure is not a critical issue.

Some car manufacturers undertaking the development of FCVs are Daimler–Chrysler who have a joint venture with Ballard, EXCELLSIS, Ecostar and Ford, General Motors with Opel, Honda, Mazda, Nissan, Renault, Toyota, Volkswagon and ZeTech. While some of these manufacturers are attempting to develop pure fuel-cell powered FCVs, others are attempting to develop vehicles either with a fuel cell–battery hybrid system or with a fuel cell–supercapacitor hybrid system. The problems that remain to be tackled are reduction in cost, weight and volume of fuel-cell systems, further improvements in driving dynamics, durability and reliability, development of cost-effective production technologies and installation of refuelling infrastructure for methanol and hydrogen. Although each of these problems represents a big challenge, FCV developers look committed to commercialize FCVs, and some of them as early as the middle of this decade.

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Quasicrystals–2001*

The first conference on quasicrystals (QCs) in the new millennium had A. Yamamoto and A. P. Tsai as its Chairpersons. The aim of the conference was to bring scientists from various fields to have new views on QCs, to share recent excitements and achievements, and to gain new insight linking fundamental research with practical applications. There were nearly 140 participants from more than fifteen countries, mainly from Japan, Germany, France, Korea, India, China, UK, USA, The Netherlands and Switzerland. There were four participants from India – S. Ranganathan (IISc), N. K. Mukhopadhyay (BHU), Alok Singh (Kalpakkam) and M. Abu Shaz (BHU). S. Ranganathan chaired one technical session. The scientific programme consisted of 60 oral presentations in 16 sessions and 70 poster presentations in two sessions, totalling 130 papers, which covered many important issues in QCs, including applications, metallurgy, crystallography, phase stability, structure, dynamics and defects. In the following we will highlight some important and interesting discussions.

*A report on the International Conference on Quasicrystals, 'Quasicrystals–2001', sponsored by CREST, Japan Science and Technology Corporation and National Institute for Materials Science (NIMS) Japan, and held during 24–28 September 2001 in Sendai, Japan.

Applications

It is important to note that the first session after the welcome address, was on the issue of application of QCs. In this session, development of two QC

composite materials was discussed. V. V. Shears *et al.* (USA) reported new polymer–QC composite materials with a unique combination of super high hardness and extraordinarily low abrasion. In fact, the wear properties of the polymer–QC composites are significantly improved over the polymer alone. These properties are superior to other polymer–hard filler composites containing silicon carbide and aluminum oxide, presumably due to the low surface energy and high hardness of QCs. In the area of bio-implant materials, the polymer–QC composite materials appear to have the potential to replace the polyethelene materials, which are being currently used for bone and joint replacements, although extensive studies must be conducted before this application is realized.

D. H. Kim (Korea) discussed the development of composites of Mg–Zn–Y alloy, where QC particles are distributed in microscale as reinforcing agents. The quasiperiodic lattice structure of icosahedral (I) QC phase was found to be stable under deformation up to the test temperature of 0.93 T_m, (where T_m is the alloy's absolute melting temperature), confirming that the icosahedral phase thermally equilibrates with Mg-rich solid solution in the alloy. The alloy exhibits greater strengths and larger elongations and fails without the formation of particle-matrix debonding at elevated temperatures. E. Macia (Spain) presented a theoretical study on the possible use of QC as potential thermoelectric materials. By comparing the theoretical results with available experimental data, it has been suggested that icosahedral Cd–Yb and the dodecagonal Ta–Te binary phases are two promising candidates for thermoelectric applications. M. Yoshimura and A. P. Tsai (Japan) showed that QC can be used as precursor of a catalyst making use of its brittleness and thermal stability. Al–Cu–Fe-stable QC has been used for methanol steam-forming reaction ($CH_3OH + H_2O = 3H_2 + CO_2$). The catalyst was prepared by ball milling and leaching with NaOH to attain high surface area. The catalyst exhibited activity (235 H_2 ml/g min at 553 K), which is comparable to that of Cu-based industrial catalyst.

Synthesis

Though QCs have been synthesized in a number of alloys classified into three important categories, namely Al-based, Ti-based and Mg-based QCs, there were excitements in this conference about the discovery of many new types of QC. There are also attempts to understand the basis for the synthesis of quasicrystalline materials. A. P. Tsai's group has synthesized a number of new QCs in Cd–Mg–Re (Re = Y, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ca) and binary Cd–Ca and Cd–Yb systems. Electron diffraction studies have confirmed that these Cd-based QCs are primitive type, with a quasilattice constant a = 0.5571–0.5816 nm and proportional to a weighting Goldschmidt atom diameter of QC by a factor of 1.75. Composition ranges of some QCs are very wide; for example, Cd–Mg–Yb QC exists in the range of 25–85% Cd, 0–60% Mg and 10–20% Yb. Valence electron number per atom of the Cd-based QC, e/a is found to be 2.0–2.2, indicating that this is a new class of QC. Ishimasa (Japan) reported new QCs in $Zn_{85}Mg_5Sc_{15}$ and $Zn_{84}Mg_8Ti_8$ with the average e/a = 2.15, and 6-d lattice parameter 0.7023 nm, which apparently indicates that this class is of the Bergman type. It has been shown that this new type of QC is close to $Zn_{17}Sc_3$ 1/1 cubic approximant phase (a = 1.3822 nm). This phase consists of triple shell cluster very similar to that of Cd_6Yb crystal. These evidences suggest that Zn–Mg–Sc and Zn–Mg–Ti icosahedral QCs belong to the same structure type as the Cd-based icosahedral QC. However, Zn–Mg–Ti system shows *P*-type QC as well as *F*-type QC, exhibiting a very weak superlattice reflection. QCs in both these systems have common features with regard to diffraction intensity, stoichiometric composition and average concentration of valence electrons. It should be noted that Zn–Mg–Ti is the first example of a QC containing an element with four valence electrons (such as in Ti) in Zn–Mg-based alloys. This may become a guide to find new alloy systems forming an icosahedral QC.

J. Saida *et al.* (Japan) have found a nano IQC phase during primary crystallization from the amorphous phase in melt-spun $Zr_{70}Pd_{30}$ and $Zr_{80}Pt_{20}$ binary alloys. These QC phases can also be synthesized in melt-spun ribbon form by controlling quenching parameters. The formation of nano IQC phase has been attributed to diffusion-controlled growth. The medium-range order with icosahedral atomic configuration has been observed in HREM images. S. Ranganathan has studied the formation of IQC and other crystalline phases from Hf-based glassy alloys such as Hf–PM–TM–Al, Hf–PM–NI and Hf–PM–PM, where PM = Pd, Pt, Ag, Au; TM = Ni, Cu, Co, Fe. The formation of the primary IQC phase has been observed in definite composition ranges in alloys containing PM, Al, Ni or Cu. The replacement of Ni and Cu by Fe or Co as well as exclusion of Al led to the appearance of Fd3m cF96 phase in preference to the IQC. Alok Singh *et al*. (India) showed the formation of nano QC of 50 nm size from Zn_2Mg-type hexagonal phase in $Mg_{60+x}Cd_{25-x}Yb_{15}$ alloy matrix with a definite orientation relationship, viz. hexagonal axis along two-fold axis of the IQC phase. New stable IQC have been reported by S. Takeuchi and co-workers (Japan) in Al–Pd–Ru and Al–Pd–Os systems, who have also compared their electrical properties with those of crystalline approximants. Many crystalline approximants to decagonal QC in Al–Rh–Si ternary systems were also presented during the poster session by N. Koshikawa *et al*. (Japan). M. Abu Shaz *et al*. (India) synthesized the nano QC in Ti–Zr–Ni and studied the microindentation behaviour of this material. It was demonstrated that the fracture toughness improves due to the formation of nano-scale microstructure.

Stability and structure

K. Edagawa (Japan) presented a video recording of *in situ* high temperature high resolution transmission electron microscopy (HRTEM), showing the thermal fluctuation of phasons in Al–Cu–Co decagonal QC. A tiling pattern with edge length of 2 nm was constructed by connecting white dots in HRTEM images. Local tile-rearrangements, which can be interpreted as phason flips were observed at temperatures higher than and equal to 1123 K. M. De Boissieu (France) investigated structural quality and phason fluctuations in the IQC (Al–Pd–Re) and IQC (Cd–Yb) phases using high resolution synchroton X-ray diffraction technique. A systematic correlation between diffuse scattering and possible fluctuations of phason was established. From this study, it was indicated that QC is probably stabilized by entropy and not by enthalpy, implying that QC may not be a ground-state phase. N. K. Mukhopadhyay (India) reported the transformation of the deca-

gonal phase in Al–Cu–Co system to a B2 phase, by high energy ball milling. Powders milled for more than 10 h in planetary ball mill contained predominantly B2 phase, with lattice parameter of 0.29 nm. This crystalline phase is found to be quite stable even after 30 h of milling and also during subsequent annealing at 600°C. These experimental evidences led the author to conclude that DQC in Al–Cu–Co is actually less stable than B2 phase at low temperature. X-ray diffraction patterns of various Al–Co–Ni, Al–Co–Cu–(Si), Al–Ni–Fe phases showing the diffuse layers perpendicular to the periodic axis were presented by F. Frey (Germany). These layers were interpreted due to 1D 0.8 nm superstructure. More or less diffuse modulations within the layers were attributed to lateral correlations in columnar clusters. E. Weidner *et al*. (Germany) reported transient ordering states in decagonal $Al_{72}Ni_{12}Co_{16}$ at temperatures up to 1000°C. High resolution X-ray measurements revealed peak splitting consistent with the domain structure of 2D *qp* and 1D *qp* lamellae. It was concluded that disordering in Al–Ni–Co phase is governed by complex transient ordering states.

D. Holland-Moritz (Germany) showed, by systematic *in situ* elastic neutron scattering and energy dispersive diffraction experiments, the presence of short-range icosahedral ordering in deeply under-cooled liquids of alloys forming quasicrystalline and polytetrahedral phases (Al–Cu–Co, Al–Cu–Fe, Al–(Fe, Cu)). K. Sugiyama (Japan) demonstrated that the structure of a W–(Al–Co–Ni) crystalline phase is related to Al–Co–Ni decagonal QCs, by using single crystal X-ray diffraction and high angle annular dark field STEM together with HRTEM.

A. Yamamoto *et al*. (Japan) reported the structural refinement of Al–Pd–Mn QC by using Imaging Plate (IP) Weissenberg camera. A 6D model proposed previously was modified during refinement. The final model included 90 structural parameters and yielded a R factor (R_w = 0.057 and R = 0.057) for 377 independent reflections. The average lattice concepts in the context of structures of QC were discussed by J. Wolny (Poland) and W. Steurer (Switzerland). It was shown that though this idea is useful for understanding many properties and diffraction features, there is no unique way of describing the QC structures. C. Henley *et al*. (USA) studied the structure of $Al_{70}Ni_{21}Co_9$ near the basic Ni phase composition almost from first principles with the help of two inputs: (a) pair potential calibrated by *ab initio* total energy calculations and (b) experimental knowledge of the approximate composition and lattice constants. The structures were represented as decorations of random tiling, which was shown to differ from the cluster model proposed by Yan and Pennycook (*Nature*, 2000, **403**, 266).

Surface and bulk properties

M. Feuerbacher (Germany) presented the role of dislocations (both screw and edge) in the context of deformation of QC at moderate temperatures. It is known that QC exhibits brittleness because dislocations are not able to move. However, at high temperatures it shows ductility due to the mobility of dislocations, which is different from that of other brittle materials. This has been demonstrated in Al–Pd–Mn, Zn–Mg–Dy as well as Al–Ni–Co QCs. Kim and co-workers (Korea) compared tribological behaviour of thermal-sprayed QC coating layers for possible industrial applications of QC materials as low-friction and anti-wear coating.

Y. Yshii (Japan) studied the electronic structure of several cubic crystals, Cd_6M (M = Yb, Ca, Sr, Mg, Y), which are approximant phases of newly discovered Cd-based QCs, by the tight-binding linear muffintin orbitals method. A shallow dip in the DOS appears near the Fermi level and the diameter of the Fermi sphere for Cd-based compounds coincides with the (222100) and (311111) reciprocal lattice vectors, as is the case for the family of QCs with e/a = 2.1. It was emphasized that the Brillouin zone–Fermi surface interaction is not essential in making a dip in the DOS. However, cohesion of the Cd-based compounds is due to hybridization of *d* states of Yb/Ca with a wide *sp* band. In addition to the electronic origin, matching of the atomic size is found to be very crucial for QC formation of Cd-based alloys. It was suggested that the glue atoms, which do not participate in the icosahedral cluster, play an important role in stabilization of the compound.

R. Mcgrath (UK) studied clean surfaces of $Al_{70}Pd_{21}Mn_9$ and $Al_{72}Ni_{11}Co_{19}$ using STM. He showed that Penrose tiling can be reconstructed on the surface and it is consistent with the bulk model of Steinhardt *et al*. (*Nature*, 1998, **396**, 55). The surface was also investigated after adsorption of C_{60} on the surface of the QC. It was found that C_{60} molecules bonded with the Al atoms on the QC structure. P. A. Thiel (USA) discussed atomic arrangement on the surface of bulk QC and correlated friction and epitaxial behaviour of QC phases. J. M. Dubois *et al*. (France) studied wetting and fretting behaviour of QCs and correlated with the density of states at the Fermi energy of QCs. It was observed that such a behaviour is also dependent on oxide layers. The present investigation has challenged the conventional theory of wetting for metal surfaces. R. Bastaz (USA) investigated the surfaces by low energy ion scattering measurement and concluded that the surface layer is rich in Al and the subsurface layer is rich in Pd. It was also reported that the top layer is deficient in Mn. This explains why frequently the pentagonal clusters are observed under STM. D. Naumovic *et al*. (Switzerland) investigated the three-fold surface of Al–Pd–Mn QC phase by two structure-sensitive techniques, i.e. XPD and LEED (X-ray Photoelectron Diffraction and Low Energy Electron Diffraction), and by electronic structure-sensitive technique. After Ar^+ sputtering and annealing at 400°C, a crystalline phase (bcc), characterized by a Fermi edge was observed.

In the concluding session, P. A. Thiel summarized the presentations of the conference and emphasized upon some of the important issues, which need to be resolved in the near future. It is important to mention that all the papers presented in this conference will be published after a peer review in *Journal of Alloys and Compounds* as a special issue. S. Ranganathan, co-chairperson of the next QC conference (ICQ8), invited all the participants to the International Meeting on Quasicrystals to be held in Bangalore from 8 to 13 September 2002.

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Solid state nuclear track detectors*

The National Seminar on Solid State Nuclear Track Detectors (SSNTDs) held recently is a prelude to the XXI International Conference on SSNTDs to be organized in October 2002 at Delhi, under the auspices of International Nuclear Track Society (INTS).

H. S. Virk (President, NTSI) in his keynote address gave a historical introduction and referred to the early work of R. L. Fleischer, P. B. Price and R. M. Walker at GEC, Schenectady, USA during the sixties. In his invited talk, R. H. Iyer (CSIR Emeritus Scientist at BARC, Trombay) discussed the role of ion track membranes in industry and a project for their mass-scale production in India using heavy ion beams from accelerators. K. K. Dwivedi (Vice Chancellor, Arunachal University, Itanagar) in his invited talk elaborated innovative tracking techniques and studies carried out on channelling of swift heavy ions in crystals.

The three-day symposium was divided into ten sessions, including one poster session. There were forty oral presentations, ten poster sessions and ten invited talks. S. Singh (GNDU, Amritsar) presented results of his group's work on uranium, radium and radon in the environment of Himachal Pradesh. S. Kumar (DRL, Jodhpur) discussed radiation dosimetry concepts and use of SSNTD films in neutron dosimetry. S. K. Chakravarti (REC, Kurukshetra) reviewed the field of micro/ nanotechnology using nuclear track filters as templates and the fabrication of devices. R. Prasad (AMU, Aligarh) highlighted the role of positron annihilation spectroscopy (PAS) in the study of modifications induced by heavy ions in polycarbonates. Rajiv K. Puri (PU, Chandigarh) presented a theoretical paper on multifragmentation in heavy ion nuclear reactions and cluster model. P. C. Kalsi (Radiochemistry Division, BARC) brought into focus gamma irradiation effects on track registration properties of polymer detectors in his invited talk. T. V. Ramachandran (EAD, BARC) reviewed indoor radon/thoron levels in Indian dwellings based on the studies carried out under the Coordinated Radon Project under DAE. It may be mentioned here that for mitigation of radiation hazard, the radon action level has been fixed in the air of dwellings and in drinking water in most of the European countries, but there is no such limit recommended by the Government of India or DAE, as a safeguard for public health. A radon map for India needs to be prepared on priority and the 'hot spots' identified, if any.

A session was devoted to ion tracks technology and its diverse applications. D. Gopalani (DRL, Jodhpur) presented medical applications of nuclear track filters. He demonstrated the use of filters in hospitals for slow drug release in curing skin ailments. Japan and Germany are the only other two countries engaged in this type of research activity. Virk highlighted the rise of radon emanation and its correlation with microseismicity in Kangra valley. R. C. Ramola (Garhwal University, Tehri Campus) presented his results on equilibrium factors for radon and thoron progenies in Garhwal dwellings. V. M. Chaubey (WIHG, Dehradun) discussed the results of his survey carried out in the Doon valley for radon concentration in groundwater. He correlated the radon concentration with uranium mineralization and tectonics of the Doon valley.

C. M. Lilly (Calicut University) gave a presentation on neutron-induced reaction studies in boron and copper using CR-39 detector. V. B. Joshi and R. V. Kolekar (RSSD, BARC) discussed a computer-based image analysis system for measurement of alpha-particle tracks in CR-39 detector. D. S. Srivastava and M. Mujahid (AMU, Aligarh) discussed the results of a study of dielectric loss with frequency in heavy ion irradiated polymers. Measurement of absolute fission yield of short-lived fission products in the fast *n*-induced fission of thorium by track etch and gamma-ray spectrometry was presented by A. Ramaswami (BARC). Bhajan Singh (Punjabi University, Patiala) presented his work on *K*-shell Compton cross-section. P. Mukherjee (Kolkata University) analysed the radon data of Palampur station collected by Virk *et al*., by using a mathematical model to filter noise from the signal, i.e. the influence of meteorological variables.

Almost 50% contributed papers presented at the symposium dealt with radon monitoring in dwellings. H. M. Mahesh (Mangalore University), P. Y. Reddy (Osmania University, Hyderabad), J. Sanappa (Mysore University), V. I. Narasimham (IIT, Kharagpur) and R. S. Kher (Science College, Bilaspur) presented radon monitoring results in dwellings as a part of DAE-sponsored national radon survey project in India.

*A report on the Twelfth National Symposium on Solid State Nuclear Track Detectors organized during 29–31 October 2001 at DAV College, Jallandhar, Punjab under the auspices of Nuclear Track Society of India.

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Aerowoman*

The main objective of the seminar was to bring together the Indian women in the field of aerospace and identify their scientific and technical contributions. In this context, the seminar was perhaps the first of its kind held in India. It was also aptly conducted in the 'Women's Empowerment Year – 2001' declared by the Government of India.

After the welcome address by T. S. Prahlad (Director, NAL), Kalyani Vijayan (NAL), provided an introduction. A unique feature of the inaugural function was a felicitation of the septuagenarian Usha Sundaram, the first woman pilot of the country. Usha Sundaram who had co-piloted India's first Prime Minister Pandit Jawaharlal Nehru, reminisced over some of her memorable experiences.

*A report on the seminar on 'Women in Aerospace in India' acronymed 'Aerowoman' held at the National Aerospace Laboratories, NAL, Bangalore, during 13–14 December 2001.

Nearly 225 registered participants from more than 15 different organizations took part in the seminar. Most of the participants were women. The colourful gallery included scientists, students and a few pilots. The technical programme consisted of 6 invited lectures and nearly 55 contributed papers. The latter were presented in two parallel sessions. As 'aerospace' is a broad area, understandably, the invited talks as well as the contributed papers encompassed different aspects of the subject.

Features of NISHANT, a short-range tactical UAV system, were discussed jointly by Malathi Limaye and Jharna Majumdar (Aeronautical Development Establishment (ADE), Bangalore). They emphasized on Data Link and Tracking system. The capability of the NISHANT ground image exploitation system developed at ADE was also presented. G. Rohini Devi provided an overview of the activities on high temperature composites being carried out at DRDL, Hyderabad. She also touched upon the role of functionally graded materials (FGM). Harpreet A. De Singh (Air India, Mumbai) talked about the challenges facing the aviation industry in the light of newer regulatory requirements. She discussed the details of tackling overcrowding of airspace without compromising on air safety, by using special operations like MNPS, RVSM, and ETOPS. Satellite communication enables users to communicate from any two points on the earth. Thus terrestrial voice/data communication service is accessed in the absence of land-based cellular service. Kamalini Martin (ISRO Satellite Centre, Bangalore (ISRO-B)) dealt with various aspects of satellite-based mobile communication. Flight simulation has been accepted as an inevitable tool in aircraft design. Padma Madhurnath (NAL) described the basic concepts of flight simulation and their role in the contemporary aircraft design in India.

As in the case of the invited lectures described above, the contributed papers also included flavours from many different areas of aerospace. To mention a few, the papers were concerned with varied topics such as check-out operations, propellants, space astronomy, aerodynamic perspective of rockets and launching vehicles, visibility in airports, materials in aerospace, system engineering, structural aspects, standards, data handling, software development, aeroengine, INSAT 2E, GSAT-1, Hansa-3, LCA, etc. Seetha (ISRO-B) described the important development areas in space astronomy and also dealt with ASTROSAT – an Indian multi wavelength astronomy satellite. The paper by Chinmayee Madhavan (NAL) described the technical aspects of a fatigue meter which can be used for 'in service load monitoring' and thus quantify the fatigue damage incurred by an aircraft. Meera Kaushal (GTRE, Bangalore) presented the details of a facility, first of its kind in the country, to conduct design validation tests on the cooling performance of turbine vanes at all significant conditions of an aircraft flight mission. The seminar enabled identification of the wide range of contributions from Indian women to the field of aerospace.

Usha Sundaram, the first woman pilot of India.

The panel discussion on the topic 'Contributions from Indian women to aerospace – Present scenario and future' conducted on 14 December 2001 was lively. The panel discussion was chaired and conducted by Air Marshal P. Rajkumar (Programme Director (FT), Aeronautical Development Agency, Bangalore). The panel members were Chanchal Uberoi (IISc), Sundari Pujari (Director (Air), Ministry of Defence, Delhi), Harpreet A. De Singh, T. S. Prahlad and Kalyani Vijayan. A proposal for starting a new division/chapter for 'Aerowoman' under the aegis of the Aeronautical Society of India, was unanimously welcomed by the panel as well as the participants. As part of the panel discussion it was suggested that new, performance-based awards for women may be instituted. These awards should not, however, prevent women from contesting for general awards, along with men. To encourage more women to enter the field of aerospace, it was suggested that attractive scholarships to graduate and postgraduate students in aerospace, may also be instituted.

The website www.nal.res.in and the extension www.nal.res.in/aerowoman.html provide further information about the seminar.

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