MATERIALS SCIENCE & TECHNOLOGY

WE ARE GOOD FOLLOWERS BUT NOT LEADERS !

E.S.R.Gopal,
Emeritus Professor, Department of Physics,
Indian Institute of Science, Bangalore 560 012.

Preamble

The first part of the talk, given on Friday the 5th April 2002 at IGCAR, was concerned about a survey of the progress of Materials Science especially in India during the past fifty years and the future directions of work which may be expected. The second part of the talk was concerned about the worries and pitfalls in our approach to Materials Science & Technology, which have to be avoided. It was widely felt that this part would be of interest to the Materials community at large and hence is being reproduced here. Any suggestions and comments are most welcome.

Worries and pitfalls

While many topics in materials science and technology hold promise for a rosy future in basic research and in technical applications, there is also concern about some problems, which are likely to be faced. Purely technical difficulties would be present and would eventually be overcome with sustained effort, including accidental developments, which come from the trained and prepared minds. There are however issues related to priorities and value systems, some of which are unfortunately very vexing in the Indian scene. The first such issue is the vexing tussle between materials preparation versus materials characterization. In the early days of the subject various materials were often prepared by trial and error and occasionally with intuition. The measurement of the physico-chemical properties and the analysis of the micro-structure were done to understand the material and to interpret the behavior of the material. The manufacturers of the scientific instruments have produced very sophisticated analytical instruments to facilitate this process. In India the result has been a distortion of the value system, with materials characterization being considered modern and sophisticated whereas materials preparation is delegated to the position of an unglamorous old task which can be done by mere technicians. Moreover the materials preparation is often done with sweat and tears in front of hot furnaces for long hours, whereas the characterization is done in air-conditioned clean environments. Thus young scholars and workers are being driven away from the ‘drab’ preparation work to the cozy characterization work. In many departments the facilities for materials preparation are also being replaced by expensive analytical instruments. Hard and painstaking experimental work is being replaced by modeling work done in relative comfort. It is not clear whether first rate work can come from borrowed samples.

The second of the issues is the complex interaction between cooperative work versus individual bases. Modern materials science and technology is very definitely multi-disciplinary, requiring inputs from experts in metallurgy, ceramic sciences, chemistry, physics, mathematics and in recent times from computer sciences. Even in one place there is need for many facilities operated by different experts to be performing in an optimum way. All these require cooperative work among the scholars concerned. Here the Indian experience has been somewhat poor. There is rarely cooperation among equals. A senior person is often able to order things to

work under his or her control. So there is a tendency to build empires attempting self-sufficiency. The academic assessments of giving weight to individual performance and down-playing institutional work has also contributed to this disease. The joke about Indian workers is probably sadly true. 1 (one) and 1 rarely result in 1 plus 1 equals two and almost never end as eleven; the result is mostly 1.1 and often 1 minus 1 equals zero

The third contentious issue is the attitudes towards directed work versus open-ended work. Basic research and applied developments must both have directions, namely to understand some properties or to produce something new. For example the effort to understand the irreproducible behavior of semiconductors resulted in the knowledge about the effects of doping and ultimately lead to new devices and new knowledge. The explanation of why pure metals are weak came as a result of the knowledge about dislocations. In directed research the goals are clear, even if the final results are unexpected. In basic research it is definitely desirable to have an idea of the broad field and the general directions. The so-called accidental discoveries are all found, on close scrutiny, to be the events coming before the prepared mind, which is ready to realize the significance of the unexpected observation. Often in India some material is studied or some instrument is used just to produce a scientific paper, because the scientific papers have become the over-valued commodities of Indian research.

The fourth of the problems is the rivalry between fashion areas versus native strengths. Globally there would be some band-wagon effect when some new topic suddenly becomes important. The situation is no different in India. Whenever some topic like quasi crystals or superconducting ceramics become topical, Indian scientists and engineers are able to start their work quickly. The question to be asked, for which there is no easy answer, is why Indians have not make any significant discovery as the first in the world ? We appear to be good followers but not able leaders. The follower has advantages in being invited to international conferences and international visits because of the visibility of the subject. If one is a leader one invites competition and has to be a lonely crusader. Some sociologists point out that one has a better chance of being a leader if one follows native strengths rather than imitate activities which are currently fashionable. The history of science is full of such examples. Even in India the field of medical research has the glaring example of AIDS research as compared to the work on Ayurveda or Yoga. The question to be faced by the Indian materials science and technology community is whether they are happy to perform imitative R & D work or be bold to seek out new line for the first time.

These and similar thoughts articulated above must have occurred to several Scientists and Engineers during the course of their professional career. They must have caused concern and anguish. There is clearly no single magic wand that can wish away all these maladies. The purpose of putting down here the above few points is to initiate a debate/dialogue so that we as professionals can evolve a set of corrective measures that will eventually lead to a vibrant and purposeful Materials community. We have to live with optimism, be prepared to learn from our past and apply those lessons for improving our future.

Acknowledgements

The author has profited from discussions with numerous senior colleagues in framing these ideas and the help from many younger colleagues in preparing the

talk.

Please send your comments/ suggestions to gopal@physics.iisc.ernet.in