nature materials Vol.4 No.8 August 2005 www.nature.com/naturematerials

Nano-express from New Delhi?

R.BALASUBRAMANIAM, IIT, KANPUR

THE DELHI IRON PILLAR, STANDING FOR 1,600 YEARS WITHOUT CORROSION, IS A SYMBOL OF INDIA'S GLORIOUS PAST IN MATERIALS SCIENCE.

Having missed the semiconductor 'bus', India does not want to overlook the nanotechnology revolution. In fact, it wants to be at the forefront of it. Can it do it?

It has the credentials. Indians made corrosion-resistant iron 1,800 years ago and gave the world the toughest steel in 300 BC. In recent times — when India has been faced with refusals by the US and its allies to sell it their militarily sensitive technologies — its materials scientists delivered hardened steel for missiles, carbon composites for fighter aircraft, and carbide fuels for nuclear reactors. Indian materials science has been waiting for a renaissance. That moment seems to have arrived.

Research at the nanoscale in India — primarily funded by the Ministry of Science and Technology — is still in its embryonic phase. Scientists have, however, established capabilities for synthesis and characterization of nanoparticles, nanotubes and nanowires. Synthesis of Y-junction tubes[1], electric-field generation due to fluid flow over carbon nanotubes[2], biosynthesis of gold nanoparticles[3] and insight into the inverse Hall–Petch effect[4] are seen as major breakthroughs. But what India has been lacking is focus and direction.

These issues have now been addressed by the ministry with the creation in February 2005 of the Nano Science and Technology Mission (NSTM) with assured funding of $25 million in 2005, $50 million per year from 2006 until 2010, and $125 million annually from 2011. This is significant considering the science ministry's total research and development budget of $70 million for physical and engineering sciences and $100 million for life sciences in 2005. C. N. R. Rao, a leading materials scientist who heads the NSTM, says that nanotechnology is not a bandwagon, as some critics allege, but an "express train" that New Delhi cannot afford to miss. In fact, India expects to enhance its visibility in this area by hosting the International Conference on Advanced Materials (ICAM 2007)[5].

The NSTM lays equal thrust on basic research and technology development in four focused areas: nanoscale surface coatings, phosphors for lighting and display, drug-delivery systems and electronics. The NSTM expects to promote foreign collaborations and create venture funds for startups and, over the years, build up the infrastructure in some 12 public-funded institutions and national laboratories to make them globally competitive in nanotechnology.

A networked programme of a size such as the NSTM is bound to face unique administrative and logistic problems. It's organizational structure, which is still being evolved, should ensure projects are carefully peer-reviewed and funded strictly on merit. Regarding technology development, it would be prudent to take note of Taiwan — where they specialize on computer chips rather than the whole computer — and focus on specific components, for instance, read or write heads for memory devices.

Riding the nano express will no doubt make India feel good. But whether nanotechnology will lead to wealth creation — as IT or biotech did — depends on how soon the NSTM is able to awaken the local industry (a potential flow sensor developed two years ago[2] still has no takers). One way out is to enable NSTM's own scientists to establish startups by providing initial funding. One successful startup could lead to a snowball effect and encourage bigger companies to step in.

In the absence of a homegrown advanced material-based industry, the likely beneficiaries of any leads from NSTM will be multinational companies such as General Electric with their research and development centres in India. In fact, three potentially marketable nanoproducts that came recently from Indian labs — anti-corrosion coating for the aerospace industry; low-temperature soldering of lead; and inorganic nanoparticles for gene delivery[6] — are currently being exploited by US firms.

Because the luring of trained scientists and PhD students with attractive salaries by multinational companies is rampant, an aggressive recruitment drive is urgent. Appealing to 'patriotism' and offering greater freedom in the work environment is not enough to persuade expatriate scientists to return to government and university labs. NSTM certainly cannot match corporate salaries — but it can reduce the disparities. Rewards for good performance and removal of bureaucracy will do the rest. India has talent. What it needs is a systematic strategy to harness it.

References
1. Satishkumar, B. C. *et al. Appl. Phys. Lett.* **77,** 2530–2538 (2000).
2. Ghosh, S., Sood, A. K. & Kumar, N. *Science* **299,** 1042–1044 (2003).
3. Shiv Shankar, S. *et al. Nature Mater.* **3,** 482–488 (2004).
4. Padmanabhan, K. A. & Gleiter, H. *Mater. Sci. Eng. A* **381,** 28–38 (2004).
5. http://www.igcar.ernet.in/mrsi/
6. Maitra, A. N. *et al.* US patent 6555376 (2003).