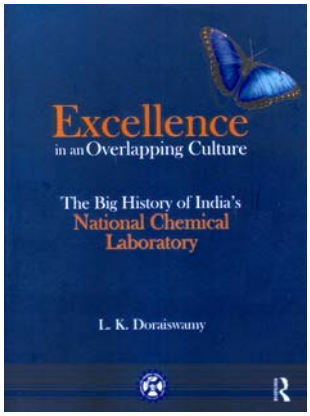

Excellence in an Overlapping Culture: The Big History of India's National Chemical Laboratory. L. K. Doraiswamy. Routledge, Taylor & Francis Group, 912-915 Tolstoy House, 15-17 Tolstoy Marg, Connaught Place, New Delhi 110 001. 2011. xviii + 607 pp. Price: Rs 1495.

The book under review is a historical account primarily of the National Chemical Laboratory (NCL), Pune, set up in the forties under the Council of Scientific and Industrial Research (CSIR) along with other scientific and academic institutions in the country within the broader context of India's scientific and technological progress made essentially since her political independence, and also taking into account the traditions and achievements arising from her rich heritage of excellence in knowledge since the days of the Indus Valley Civilization. This outstanding contribution would not have come about except for the continued request and perseverance of from one of his distinguished successors. To quote S. Sivaram from a personal communication,

> 'As you must have read in the Preface, I asked Dr L. K. Doraiswamy, who is 84 now, to attempt this biography of NCL. He was a former Director and somebody who grew up to eminence in CSIR–NCL, joining in a junior level in 1952. His memory of the institution was near complete having known seven of the eight Directors including me. He was also responsible for bringing in Dr Mashelkar, my predecessor, Dr Paul Ratnasamy and myself into the laboratory and consciously build the leadership pipeline. This project began in 2003 and was completed in 2009. In between L.K.D. became seriously ill twice requiring admission in the hospital, causing inevitable delays. He persisted, in spite of his failing health, and he completed this monumental task. As you are aware he has been living in the US for the past twenty years. Of late his health has not been very good. He often told me that this would be his last book! He loved this institution and it was a great labour of love for him to write this book. I have always felt that in our country we do not document the history of institutions. As generations pass, something special about the culture and ethos of institution dies. Only a written book can convey the spirit of the institution to the next generation. This book is an attempt to accomplish this. Also in India, institutions of higher learning and scholarship have a high rate of decay, unlike in many other parts of the world. I have always wondered how some institutions continue to retain their eye for excellence, in spite of passing years and leadership changes. To discover and understand what sustains excellence in institutions is also important to historians of science as well as institutions.'
>
> In essence, the book is and would remain, as a bright jewel among its companions on history of Indian science and technology (S&T) in post-independent India; and I pay my respects to the author as a former junior colleague of his within the CSIR umbrella, concurrently admitting that this short review is meant only to be a catalyst for more serious ones to read it and spread the message of our growing thirst for self-reliance in S&T, the very foundation of modern development.

The contents in the book are presented in six parts and 18 chapters covering topics such as: (i) genesis/roots of excellence in chemical sciences at NCL, (ii) arrival of a modern chemical laboratory that works for the future of chemical S&T in India within the unfolding scenario both within and elsewhere, (iii) excellence in the evolution of research and development (R&D), (iv) developing appropriate technology transfer practices that aid bridging the laboratory with industries, (v) creating modern physical infrastructure and intellectual capability that could transform scientific ideas into inventions, innovations and industrially useful products and processes, and (vi) S&T roadmap as a template to the bright future of the country.

Initiatives to establish NCL at Pune in the forties and extension of the scope and content of the same policy through it and the other national laboratories under the umbrella of CSIR in the fifties onwards were guided by the national mandate of developing indigenous S&T by actively promoting domestic R&D generally at par with that of the advanced countries and help in the promotion of Indian industries through meeting contemporary requirements and thereby ultimately serve the day-to-day needs of the people at large (though it should not be forgotten that till independence the interests of the alien rulers in CSIR were primarily focused on support for war efforts only). And this formed the praxis for the much-acclaimed 'Nehru–Bhatnagar effect' for renewal of scientific and industrial research in the civil sector and the 'Nehru–Bhabha effect' for creating strategic research in atomic energy and space exploration, indeed a reflection of the convergence of political will and industrial/scientific leadership of resurgent India to rebuild the society on firm scientific and industrial foundations. And NCL was obviously one of the very fortunate institutions to benefit from the very beginning.

On the occasion of founding NCL, Jawaharlal Nehru had passionately declared the dream/vision of the laboratory in simple and pure words that 'it would expand knowledge and apply chemical sciences for the good of the people'. On the same occasion, S. S. Bhatnagar, Director General of CSIR, had in turn pronounced the policy perspectives and operational guidelines to NCL to be pursued. They included: (i) improvements and upgradations of known products and processes in the light of new discoveries, inventions and innovations worldwide; (ii) standardization of process parameters well proven on pilot-plant operations for reliability of performance upon licensing and transfer of know-how; (iii) to keep in touch with the licensees/industries all through the license period to learn and solve technical problems that may arise while the inventions are put to industrial practice; (iv) to provide technical consultancy and analytical services to the needy industries; (v) to pursue R&D both in-house and contract by grant-in-aid and/or sponsorship from industries and departments, (vi) to secure protections to

discoveries and inventions by means of intellectual property rights (IPRs)/patent rights in India and abroad; (vii) to earn revenue by means of external cash flows (ECFs) and license fees (premium and royalties); (viii) to promote academic excellence while in the pursuit of R&D and knowledge and human resources development (HRD) with active collaborations with academies/universities in India and abroad, and (ix) while excelling itself in the field of chemical sciences, NCL needs to adopt inter/intra-disciplinary approach and matrix management by drawing resources and talents from across the disciplines duly nurtured in the laboratory. With the foremost UK scientist, James Mc Bain himself as the first Director, NCL was born 'with a silver spoon in its mouth'. The book summarizes the evolution of NCL as a vast and expansive science and engineering education research campus with very few parallels in the country among the civilian units, generally in accordance with the above dream/vision/mission of a 'scientific and industrial research' vision matching with requirements of the times.

The book identifies four plus one phases of NCL development in the last 60-plus years. Domain 1 (a long one indeed!) during 1950–65 successively under the directorship of James Mc Bain (1949–52), George Finch (1952–55) and K. Venkataraman (KV; 1955–65) engaged in creating in various chemical and allied disciplines, recruitment and deployment of outstanding scientists of whom many had research experience under the world-renowned scientists/Nobel laureates to initiate fundamental research and establish a name for itself. Domain 2 under KV (1965–68) and more substantially under B. D. Tilak (1968–77) taking major initiatives to applied research, turnkey projects and technology transfers (consultancies included) to industries and government departments and selectively also taking up rural development (obviously in accordance with the role of Tilak as an active member of the newly constituted NCST by Minister C. Subramaniam) and all these steps in turn matched through programmes for improving the HRD of the laboratory as well. He took the very unusual step of commissioning two study groups in the seventies, one by Arthur D. Little Inc, USA and another by Ravi Mathai, Indian Institute of Management (IIM), Ahmedabad, to learn about the organizational culture, work ethics, achievement motivations and performance of the staff. To his dismay, the study groups reported that majority of the scientists at NCL were a dissatisfied lot, with little role in decision-making and hence showing in turn little passion or interest in terms of novelty/originality and creativity. The author gives very great credit to Tilak for his pioneering contribution in totally reorienting the working of the laboratory more in line with its cherished agenda. Domain 3 with L. K. Doraiswamy (1979–89), NCL to attain all-round excellence in developing quite a few state-of-the-art technologies and publication of highly rated research publications achieved through addition of outstanding scientists at appropriate positions to emerge as future leaders in the field in the country. Domain 4 (1989–present) with R. A. Mashelkar (1989–95), Paul Ratnasamy (1995–2002) and S. Sivaram (2002–2010) NCL again changing its directions in accordance with the changing needs of CSIR and government/industry policies in market orientation and globalization, with special emphasis on international alliances and accelerated emphasis on capital intensity, computer inter-networking/informatics and instrumental sophistication in R&D hoping to be at par with the state-of-the-art S&T advancements in the developed societies.

Matching with the original memorandum of CSIR to be a body for 'scientific and industrial research' (the author seems to differ from the Mashelkar thesis of CSIR to be evolved into a body of 'scientific industrial research'), the author classifies the achievements separately in terms of the two relevant categories. One could grasp the essence of excellence by a galaxy of prestigious *Science Citation Index* (*SCI*) journals where the laboratory scientists have published ten or more articles. Publication of such research articles shows an exponential growth commencing from around 30 in 1950 to near 500 in 2007, including 17 papers in the prestigious *Nature*, a tradition rather rare among the Indian scientific community. A few such hallmarks in the list of scientific papers occupying cover pages of the journals include: (i) *Chem. Commun*., **14**, 24 April 2005, (ii) *J. Mater. Chem*., **15**(31), 21 August 2005, (iii) *Phyto Chem*., **63**, 2003, (iv) *Chem. A Euro. J*., **12**(6), 2006, (v) *FEBS Lett*., **346**(20), 13 June 2004, (vi) *J. Heredity*, **95**(5), September–October 2005 and (vii) *Euro. JOC*, **13**, 2002. Many scientists also have held honorary positions as members of the editorial boards of prestigious journals as well as lead/review articles and chapters in the edited books. In turn, as many as 38 scientists had received as many as 77 distinctions/titles/fellowships from prestigious science academies, including the Indian Academy of Sciences, the Indian National Science Academy, the National Academy of Sciences, the National Academy of Engineering and the Third World Academy of Sciences, with 14 Bhatnagar awardees and Mashelkar himself honoured also with the prestigious FRS. All these have been possible through its large number of high-quality Ph D degree holders and their large contingent of research students. On an average, about 150 research scholars, ranging from 50 to 450, have been working at NCL for Ph D degrees and about 50 scholars a year, ranging from 10 to 225, are awarded Ph D degrees by various universities.

On the industrial research side, the laboratory's contribution is again substantial. Unlike many other institute historians, Doraiswamy has chosen to describe not only its successes, but also its failures. Some such select successful technologies developed (and first licensee) at NCL include: (i) acetanilide (Hindustan Organic Chemicals), (ii) phthalates: dioctyl and dibutyl (Alta Labs Ltd), (iii) monochloroacetic acid (Hico Products Ltd), (iv) monoehtyl aniline (Atul Products Ltd), (v) nitrile rubber (Synthetics and Chemicals Ltd), (vi) sorbitol (Hindustan Antibiotics Ltd), (vii) vitamin B6 (Lupin Labs Ltd), (viii) endosulfan (Bharat Pulvarizing Mills P Ltd), (ix) sodium/potassium ferrocyanides (Hindustan Development Corporation Ltd), (x) albene process (Hindustan Polymers), (xi) encillium process (Dhampur Sugar Mills Ltd), (xii) catalysts for conversion of methanol to formaldehyde (International Catalysts Ltd), (xiii) ultra filtration membranes (Membrane Filters India P Ltd), (xiv) THPE technology (GE Plastics, USA/Excel Industries Ltd), and (xv) solid catalysts for bio-diesel (Benefuel Inc, USA). A select list of contract projects (for a client) completed successfully at NCL includes collaborative projects such as: (i) vitamin C (Hindustan Antibiotic Ltd), (ii) chloromethanes (Standard Alkali Chemicals), (iii) methyl chlorosilanes (Hico Products Ltd), (iv) polymer

composites to replace metals in two-wheelers (Bajaj Auto Ltd) and (v) water-proofing system for beck bond PU22 (Beck & Co.) and sponsored ones which include: (i) perfumery products based on longifolene-capinone (Camphour and Allied Products Ltd), (ii) chlorobenzenes (Hindustan Organic Chemicals Ltd), (iii) dimethyl aniline (Sahayadri Dyestuffs and Chemicals P Ltd), (iv) acrylic acid/acrylates from acrylonitrile (Indian Petro Chemicals Corporation Ltd), (v) nitrile rubber (Synthetics and Chemicals Ltd), (vi) theophylline, amilophylline and caffeine (Pefco Foundry and Chemicals Ltd), and (vii) vinblastin sulphate BP/USP and vincristine sulphate BP/USP (Cipla Ltd). Among its failures listed therein are: (i) water evaporation control, (ii) ethylene oxide, (iii) enrichment of titanium dioxide in ilmenite, (iv) fumed silica, (v) high-grade silicon and (vi) rayon-grade pulp (Rural development, etc.).

The author gives again a summary of the issues faced by Indian scientists in conducting industrial research and transfer of technology to industry as required – the travails and tribulations as well within the contemporary techno-industrial policy regimes in two rather long chapters – 'Walking through what is to come' and 'The agony and the ecstasy – brush with reality'. Quoting the famous words of Louis Pasteur, 'No, a thousand times no; there does not exist a category of science to which one can give the name applied science. There are science and applications of science, bound together as the fruit to the tree which bears it', the author truly elevates himself to a high S&T policy pedestal through his vastly acquired mastery over the subject as experienced in a less-developed society such as ours with an 'overlapping culture'. Unable to summarize even the gist, one only recommends that any serious S&T researcher must read them at least a few times to gain any meaningful information of what is otherwise written and talked about as the 'agony and ecstasy' of true industrial research and successful technology transfers, including the warning of the late Prime Minister Indira Gandhi in her NCL Silver Jubilee address in 1975, 'The Indian industrialists do not easily accept indigenous technology, however original. You must learn to be *evangelical (emphasis added)* in dealing with them!' Whether the 'industrialist's attitude' has changed over the decades, including those in the globalized scenario towards one more favourable towards higher levels of self-reliance and national pride continues perhaps as a million dollar question!

To conclude, this book is an invaluable addition to the very history itself of post-independent Indian S&T development in the civilian sector. The nation through CSIR has perhaps put its very best in NCL to make it a state-of-the-art R&D centre in scientific and industrial research. Could it rise up to the expectations to the extent needed or as projected through the Nehruian dream set on its Foundation Day? Could it have done more closely to it? Such answers can be found out only if analysed within the existing larger milieu of the national S&T and the controlling development policies. In other words, this book should serve to raise new and more serious questions on those aspects; and such an exercise could go a long way to make our civil sector R&D more relevant and development-friendly in its total sense, more so when the total regime has gone 'liberal' and global, with the Indian industry by and large going even less 'evangelist', to quote Indira Gandhi again. Every Indian will find this book an invaluable treasure in his library, to always refer in one's onward journey in search of 'excellence in an overlapping culture' so widely pervading in our country. I have been engaged for the past several years to write through my educational website (www.patentmatics.org) on the 'science and problems of development', a term used by late Homi Bhabha to describe his 'growing science' theme, of our big science institutions like DAE, ICAR and ISRO from their respective contributions in self-reliance. Undoubtedly it was clear to me from such an odyssey that the voluminous monograph *In Pursuit of Excellence, A History of the Indian Institute of Science* by B. V. Subbarayappa, was a milestone in the field; this glorious work of L.K.D. far more deeper, quantitative and scholarly in content, should indeed be described as another major addition to our scarce store of such writings. Undoubtedly time has come for extending such efforts to many more of such pioneering units which have come up in our country in many areas of specialization. Undoubtedly every research institute and S&T policy study centres in the country must keep a copy of this L.K.D. magnum opus for reference and study.

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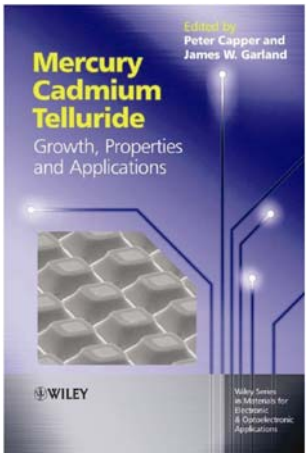

Mercury Cadmium Telluride: Growth, Properties and Applications. Peter Capper and James W. Garland (eds). Wiley Series in Materials for Electronic & Optoelectronic Applications, John Wiley, UK, 2011. xxxiii + 556 pp. Price: US$ 260.

Mercury cadmium telluride (MCT) is the dominant material for infrared sensing and imaging despite its many contestants. Some of its features, such as tailorable energy band gap over the entire infrared (1–30 μm) range, direct energy gap, high mobility of electrons, low dielectric constant, large optical absorption coefficient and long diffusion length, enable high quantum efficiencies (approaching 100% in most cases). Favourable inherent recombination mechanisms lead to long carrier lifetimes, low thermal generation rates, high operating temperatures and long diffusion lengths. Another ideal feature of the MCT band structure, only fully realized and