

Vacuum science technology and applications*

Vacuum as a working environment is an indispensable part of scientific research as well as numerous industrial applications. A recently held course on vacuum science technology and applications brought experts from India and abroad in the field of vacuum and its applications, especially in thin films and coating, beneath one roof. The 115 participants belonging to different parts of India comprised of a rich mix of research students, scientists, engineers and technicians. A wide variety of topics from basics to applications of vacuum science were discussed in-depth during the course. It included talks on vacuum science fundamentals, production of vacuum and its measurement, leak detection, components and fabrication techniques, materials in vacuum technology and applications of vacuum, mainly vacuum-aided coating.

Chandrasekhar (Central Electronics Engineering Research Institute, Pilani), in his inaugural address, discussed various applications of vacuum science and the need for understanding the overall development of the field. The course was well planned, starting with the fundamentals of vacuum science. A. K. Gupta began with an introduction on the kinetic theory of gases. His talk covered the pressure regimes encountered under various degrees of vacuum. He also discussed topics like molecular flow, pumping speed and conductance. The talk was well illustrated with numerous day-to-day examples. Yatin Nakhare (Pfeiffer) gave a talk on vacuum regions, explaining the roughing vacuum (atmosphere to 10^{-2} torr), high vacuum, ultra high vac-

uum (UHV) and extremely high vacuum (10^{-10} to 10^{-13} torr). Various types of pumps for different applications, their basic working principles and practical points to be kept in mind before using them were also discussed. The lecture on measurement of vacuum by Arindam Basu (BARC, Mumbai) was quite involved. He introduced gauges and their working principles. All the participants were given a book entitled *Introduction to Vacuum Technology*, authored by K. G. Bhushan (BARC), which covered all the topics discussed in the course. It was a good homework going through the book. B. K. Shah (BARC) gave an interesting lecture on application of vacuum in metallurgy, covering basics of metallurgy, metals and their ores, the types of bonds that make them all different, vacuum-based material characterization and vacuum based non-destructive testing for defect or micro-structure characterization. A. V. Bapat introduced the vacuum system designs, covering aspects like mechanical, thermal and vacuum designs of the system. The talk by Bhushan on UHV (10^{-7} to 10^{-10} torr) system design gave an idea about the use of UHV and the primary considerations for designing a system of UHV, which is a challenging job. Bhushan explained gas-loading concepts with calculations and also spoke about sublimation pumps and the non-evaporable getter pumps. S. C. Gadkari (BARC) talked about the analytical instruments using vacuum and the development of such instruments at BARC, the challenges faced and their solutions. A lecture on an important field in vacuum – leak detection – was given by L. M. Gantayet (BARC). Ganapati Rao Myneni (Jefferson Lab, Washington DC) talked about cryosorption pumps and cryomodules being used at the Jefferson Lab. He also introduced the Granville Phillips new combination gauge, which

can measure total as well as partial pressures.

The evening sessions of the course included some practical applications on assembling a turbo-molecular pump (conducted by Pfeiffer group). A group of participants were also taken to the Electron Beam Centre, Kharghar, to see the 3 MeV DC Linac and 10 MeV RF Linac. These have been indigenously designed and developed, and are used for various industrial applications like cross-linking of polyethylene by electron beams, teflon reprocessing, imparting exotic colours in diamond, sewage treatment, grain disinfections, food preservation and sterilization of medical products to name a few. The visit was followed by a lecture by K. C. Mittal (President, Indian Vacuum Society). He described all the above applications of the electron beams and also provided information about the future 9 MeV Linac for Cargo Scanning and 30 MeV Linac for research purposes. There were two lectures each on thin film coatings by S. K. Gupta (AERB) and plasma-assisted deposition of hard coatings for tribological applications by Patil (BARC). There was also a demonstration session on coating techniques. The course also saw participation from many companies who displayed their pumps and discussed the developments in vacuum measurement and leak-detection devices.

Thus the course provided a good synergy between theory, and practical and actual applications of vacuum science. The participants were greatly benefitted by this exposure.

*A report on the four-day course on 'Vacuum Science Technology and Applications' held by the Indian Vacuum Society from 12 to 15 May 2009 at Navi Mumbai.

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