

K. V. Ramanathan (1926–2007)

K. V. Ramanathan passed away on 8 March 2007. He is well known for his pioneering work to establish in India, a viable research and development effort in the area of semiconductor electronics. The group he established and headed for several years at the Tata Institute of Fundamental Research (TIFR), Mumbai, was acknowledged to be among the leading ones in this area in India. As the Chief Executive of the Semiconductor Complex of the Government of India, he pioneered the growth of that institution from 1976 to 1980.

Ramanathan was born in Kumbakonam, Tamil Nadu, on 17 July 1926 and studied at Thiruvadamarudur High School. Later he studied at P.S. High School, Chennai. In 1945, he graduated (B Sc Hons) in physics from the Presidency College, Chennai. According to the rules then existing at Madras University, this automatically became an M A degree after a specified time. It was common in those days for such Physics (Hons) graduates to either opt for the Indian Administrative Service or some technical services, since few research opportunities existed. All India Radio (AIR) was one of the coveted technical services, since it was a government service (and hence attractive). Ramanathan joined AIR in 1947 as a technical assistant, first in Chennai, and later on at Dharwar and New Delhi. After the Second World War, when the gates of the US universities opened, to Indian students for science, a few from AIR, New Delhi went to USA for graduate studies, and Ramanathan was one among them. At the University of California, Los Angeles, he was awarded the MS (Applied Physics) degree in 1960. After completing the course requirements for a Ph D degree, he joined the MTS, TRW Systems, California and in 1962, became a staff scientist at the Hughes Research Labs. At that time the Electronics Commission of India was active in promoting semiconductor research, and Ramanathan joined TIFR in 1964, with a mandate to set up a state-of-the-art semiconductor research laboratories. The solid state electronics laboratory at TIFR, was then one among the few laboratories in India to pioneer research and development efforts for advanced work on unit processes for integrated circuits and train young gradu-

ates in this important field. During his tenure at TIFR, Ramanathan was deputed to the semiconductor complex of the Government of India, Chandigarh from 1976 to 1980. He retired from TIFR in 1983, but continued work in the area as a Visiting Professor/Visiting Scientist at a number of places, including University of California at Los Angeles; IBM Research, New York; Rensselaer Polytechnic Institute, New York; University of Florida, Gainesville; Australian National University, Canberra, and Indian Institute of Science, Bangalore.

Ramanathan had worked in all aspects of physics of semiconductors, and devices and technology with reference to integrated circuits. In the very early stages he was involved in the original patent disclosure of TTL, devised dielectric isolation by chemical means, developed a method for depositing SiO₂ on integral silicon oxide to increase the yields. Characterizing these circuits resulted in better mask designs yielding three patents. He worked on discreet p-n-p design and fabrication, and also on the mechanism of filamentary switching in chalcogenide glasses and the Mott prefactor problem in hydrogenated amorphous silicon. He investigated the thermal stability of MOS devices, deep levels in silicon and their gettering, properties of ion-implanted oxides, XPS measurements on the effect of implanted chlorine in thermal oxides, hot electron and hole instability in thermal oxides, and modelling of three-dimensional structures made by laser annealed polysilicon.

At TIFR, Ramanathan and his colleagues established several facilities for diffusion, ion implantation, photo resist, CVD for poly-silicon deposition, epi reactor, plasma etching, plasma deposition, e-beam evaporation, and cw laser for laser annealing. Characterization equipment such as IV, CV, DLTS, four-point probe and Dektak were established. Computer-aided tools like CAD for mask pattern generation, SUPREME and MSINC were developed. His group worked intensively in the area of large scale integration (LSI) and very large scale integration. The TIFR effort, besides establishing an outstanding facility for fabrication of novel semiconductor devices, made substantial contribution to the basic understanding of semiconductor device processes. The main

fallout of these R&D efforts: (i) the TTL (gold-doped) version and the Schottky TTL developments transferred to manufacturing units and (ii) facility for R&D and manufacture of LSI devices established at the Chandigarh semiconductor complex.

After TIFR, his research on solid phase epitaxy of silicon helped build a molecular beam epitaxy system for the study of strained layer super lattices. The area of low energy (>1000 eV) reactive (oxygen) ion beam synthesis of oxides of transition metals like Cr, Cu to produce very thin films was studied extensively. Transport properties, structure, oxidation state and morphology were studied using SQUID magnetometer, X-ray diffraction, transmission electron diffraction, XPS and SEM and the composition of the films by nuclear backscattering. It was found that energy, flux and substrate temperature affect the composition and structure. His studies showed the existence of a new, as yet unidentified phase with unusual properties, and resulted in patent disclosures.

Ramanathan shared four patents: original patent for co-inventing the TTL computer circuits, 1962; deposited oxide, 1962; dielectric isolation by chemical etching, 1962 and low energy ion beam synthesis, 1986.

Ramanathan's contributions to solid state electronics were recognized by presenting him with the Vasvik award and Gold medal, 1986. He was a member of committees of the Government of India, which went into several aspects of semiconductor electronics. He was also a consultant to UNIDO, Vienna.

Ramanathan was a multifaceted person. He held a licence as a full pilot for a single-engine plane. He was also fond of Carnatic music and played tennis. He was friendly and ever keen to share his views with others.

Ramanathan had settled down in Chennai since 1995. He leaves behind his wife, a son and two daughters. He will be missed by many.

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