



## Chintamani N.R. Rao



**Date of Birth** 30 June 1934

**Place** Bangalore (India)

**Nomination** 25 June 1990

**Field** Chemical Science

**Title** Albert Einstein Research Professor

**Professional address**

Jawaharlal Nehru Centre for Advanced Scientific Research

Jakkur Post

Bangalore 560 064 (India)

### Most important awards, prizes and academies

Among the various medals, honours and awards received by him, mention must be made of the Marlow Medal of the Faraday Society (1967), Bhatnagar Prize (1968), Jawaharlal Nehru Fellowship (1973), Padma Shri (1974), Centennial Foreign Fellowship of the American Chemical Society (1976), Royal Society of Chemistry (London) Medal (1981), Padma Vibhushan (1985), Honorary Fellowship of the Royal Society of Chemistry, London (1989), Hevrovsky Gold Medal of the Czechoslovak Academy (1989), Blackett Lectureship of the Royal Society (1991), Einstein Gold Medal of UNESCO (1996), Linnett Professorship of the University of Cambridge (1998), Centenary Medal of the Royal Society of Chemistry, London (2000), the Hughes Medal of the Royal Society, London, for original discovery in physical sciences (2000), Karnataka Ratna (2001) by the Karnataka Government, the Order of Scientific Merit (Grand-Cross) from the President of Brazil (2002), Gauss Professorship of Germany (2003) and the Somiya Award of the International Union of Materials Research (2004). He is the first recipient of the India Science Award by the Government of India (2005) and received the Dan David Prize for science in the future dimension for his research in Materials Science. He was named Chemical Pioneer by the American Institute of Chemists (2005), Chevalier de la Légion d'Honneur by the President of the French Republic (2005) and received the Honorary Fellowship of the Institute of Physics, London (2006) and Honorary Fellowship of St. Catherine's College, Oxford (2007). He received the Nikkei Asia Prize for Science, Technology and Innovation (2008). He was awarded the Royal Medal by the Royal Society (2009) and the August-Wilhelm-von-Hoffmann Medal for his outstanding contributions to chemistry by the German Chemical Society (2010). He received the Ernesto Illy Trieste Science Prize for materials research in (2011).

### Summary of scientific research

C.N.R. Rao had just joined college after high school studies when India gained freedom in 1947. After his undergraduate studies in Bangalore, he obtained a Master of Science degree from Banaras Hindu University. He obtained the Ph.D degree in chemical physics from Purdue University and carried out postdoctoral research work in the University of California, Berkeley. He returned to India in 1959 as a young faculty member at the Indian Institute of Science, Bangalore, which is the oldest and the most well-known research institute of India. Four years later, he moved to the new Indian Institute of Technology (IIT), Kanpur where he soon became head of the chemistry department. Rao's early research was mainly on spectroscopy and molecular structure. Rao's first book on *Ultraviolet and Visible Spectroscopy* got published from London in 1960 and his second book on *Infrared Spectroscopy* from the US in 1963. He slowly started working on solid state and materials chemistry, his earliest paper in this area being in 1958. He faced immense difficulties in starting research in India during those years, because of financial constraints and limited experimental facilities. However, some of his papers from 1960 are still being cited. Rao slowly built facilities for research in solid state and materials chemistry in IIT Kanpur and started research on metal oxides which constitute the largest family of materials with the widest range of properties. There were very few practitioners of solid state chemistry at that time. His one-year stay in Oxford as a Visiting Commonwealth professor during 1973-74 made him realize the need to build a dedicated, well-equipped laboratory for solid state and materials chemistry which would compare favourably with laboratories in the advanced countries. With this purpose, after 14 years in IIT Kanpur, he returned back

to the Indian Institute of Science to build new departments devoted to solid state chemistry and also materials science. He succeeded in building good facilities for research by the late 1970s. In his effort to build a major research programme in solid state and materials chemistry, he was inspired by his association with Prof. J.S. Anderson and Prof. Nevill Mott.

He was director of the Indian Institute of Science during 1984-94. The Government of India decided to establish Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) in 1989 to celebrate the birth centenary of India's first Prime Minister with Rao as the founding president. JNCASR has emerged to be one of India's premier research institutions and Rao was President of the Centre till 1999. He continues to work there as Linus Pauling Professor and honorary president. One of the main areas of research at JNCASR is chemistry and physics of materials.

Rao has been publishing extensively on a variety of aspects of chemistry of materials including novel methods of synthesis, discovery of new materials, tailor-making materials with desired properties and so on, for over half a century. He has worked on high-temperature superconductivity, colossal magneto-resistance, multiferroics and open-framework materials. In the last 20 years, he has been investigating various nanomaterials, specially nanotubes, nanowires and graphene.

As of today, Rao has published around 1500 research papers and 44 books. He has around 44,000 citations with an H-index of 93+. C.N.R. Rao is on the editorial boards of several journals dealing with chemistry, chemical physics, materials science and solid state chemistry.

Rao feels that the most enjoyable aspect of his career has been working with young students. Over 150 persons have received Ph.D. degrees working with him. Besides young coworkers and post-doctoral fellows, Rao has collaborated widely with scientists in Europe and the US. In the last 10 to 15 years, Rao has been making considerable effort to bring out science education materials (books, CDs etc.) for school children. He regularly delivers lectures to children in various parts of India.

Prof. Rao is proud that he spent his entire professional life of over 52 years in India. While it was difficult to do research at the frontier during the early years of his career, he feels happy that he has been able to accomplish whatever he could and to witness India transforming slowly from a very poor country to an emerging economy. It has also been a pleasure to grow with the subject of his research which was at its infancy when he started working in the 1950s.

## Main publications

*Some of the important contributions of C.N.R. Rao to materials research with key references to his work:*

1. New Methods of synthesis of metal oxides and other inorganic materials. *J. Mater. Res.* (1986), *Acc. Chem. Res.* (1987), *Mat. Sci. Engg. B* (1993).
2. First synthesis of the liquid-nitrogen cuprate superconductor and related contributions. *Nature* (1987), *Phil. Trans. Royal Soc. (Lond)* (1991).
3. Colossal magnetoresistance in manganites and related effects. *Phys. Rev. B* (1996), *Adv. Mater.* (1997), *Chem. Mater.* (1998), *J. Phys. Chem.* (2000).
4. Metal-insulator transitions in metal oxides, and marginally metallic systems. *J. Phys. Chem.* (1995), *Chem. Commun.* (1996), *Solid State Phys.* (1999).
5. Large-scale electronic phase separation in metal oxides. *Chem. Mater.* (1999), *Phil. Trans. Royal Soc. (Lond)* (2008).
6. Precursor synthesis of carbon nanotubes, and generation of junction nanotubes and doped nanotubes. *Appl. Phys. Lett.* (1996), *Acc. Chem. Res.* (2002), *ACS Nano* (2007), *Nanoscale* (2010).
7. Building inorganic frameworks and molecule-material transformations. *Acc. Chem. Res.* (2001, 2004), *Chem. Commun.* (2006).
8. New synthesis of inorganic nanomaterials and the use of the liquid-liquid interface for the purpose. *J. Colloid Interf. Sci.* (2005), *Dalton Trans.* (2007), *Acc. Chem. Res.* (2008).
9. New routes to multiferroics. *J. Mater. Chem.* (2007),
10. Nanotubes of inorganic materials. *Adv. Mater.* (2009)
11. Separation of semiconducting and metallic carbon nanotubes. *Nano Research* (2009), *J. Am. Chem. Soc.* (2010).

12. Novel synthesis and properties of graphene, chemical doping of graphene and molecular charge-transfer with graphene. *Adv. Mater.* (2009), *Angew. Chem. Int. Ed.* (2009), *Materials Today* (2010)
13. Universal ferromagnetism in all inorganic nanoparticles. *Nanotoday* (2009).
14. Chemical storage of hydrogen in graphene, Synergy in mechanical properties of composites containing two-nanocarbons and IR detectors based on graphene. *PNAS* (2009), *PNAS* (2011), *Adv. Mater.* (2011).

*Some of the books on materials written or edited by C.N.R. Rao:*

1. *Modern aspects of Solid State Chemistry*, Plenum Press (1970).
2. *Phase Transitions in Solids*, McGraw-Hill (1978).
3. *Preparation and Characterization of Materials*, Academic Press (1981).
4. *New Directions in Solid State Chemistry*, Cambridge University Press (1986, 1997).
5. *Superconductivity Today*, Universities Press (1992).
6. *Chemistry of Advanced Materials*, Blackwell (1992).
7. *Chemical Approaches to the Synthesis of Inorganic Materials*, John Wiley (1994).
8. *Metal-Insulator Transitions Revisited*, Taylor & Francis (1995).
9. *Transition Metal Oxides*, Wiley-VCH (1995).
10. *Colossal Magnetoresistance and related phenomena*, World Scientific (1998).
11. *Nanotubes and Nanowires*, Royal Soc. Of Chemistry, (2005, 2011).
12. *Nanochemistry*, Wiley-VCH (2007).
13. *Trends in Chemistry of Materials*, World Scientific (2008).
14. *Graphene and its fascinating properties*, World Scientific (2011).