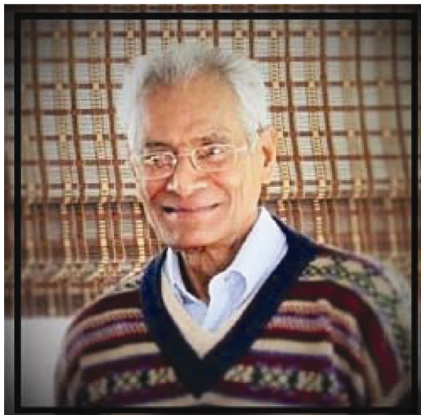
Gundlapalli Venkata Subba Rao (1940–2017)

Professor Gundlapalli Venkata Subba Rao, popularly known as GVS, an excellent solid state chemist-turned materials scientist, was born 12 December 1940 at Bapatla, Andhra Pradesh. He received his Bachelor's and Master's degrees from S.V. University, Tirupati and his Ph D degree in solid state chemistry from the Indian Institute of Technology (IIT), Kanpur as one of the earliest students of C. N. R. Rao. GVS then spent nearly three years (1971–74) at the IBM J. Watson Research Centre in New York, USA and later at the Argonne National Laboratory, USA followed by a Humboldt Foundation Fellowship Anorg. Chem. Institut der University Munster and then at University of Bohum, Bohum, West Germany. Subsequently he was invited to take charge of the Materials Research Centre (MSRC) at IIT-Madras, which he developed into an excellent research centre dedicated to materials science. GVS was a pioneer in redefining the field of solid state chemistry. He demanded hard work, creativity and critical thinking from all his students during his tenure at MSRC.

In 1992, GVS took over the Directorship of Central Electrochemical Research Centre (CECRI), Karaikudi, which he served until 1998. During his tenure, he infused new dynamism and led from the front by continuing to carry out research in the area of photoluminiscent materials, in addition to the required administrative work. He encouraged research and consultancy, and brought about the much needed reforms in its structure to facilitate good, research and fostering young minds. Subsequently, he moved to the National University of Singapore (NUS) and spent more than a decade dedicating himself to carrying out intense research in Li-ion battery materials. GVS and his team studied several electrode materials and made significant contributions.

GVS did research on a variety of topics ranging from solid state chemistry, materials science, photoluminescent materials, ternary superconducting materials, semiconductor-based photoelectrochemical cells (PECs) for solar energy conversion into electricity and/or chemical energy of a fuel as used in water splitting, mixed oxide perovskite and pyrochlore structures exhibiting interesting electrical and magnetic properties and phosphate ceramics of $NaZr_2(PO_4)_3$ structure for use in fast ion conductors, as controlled coefficient of expansion of materials for rad ways disposal. He was among the few in India to work in the field of high temperature superconductivity.

In the area of ternary superconductors, a group of materials containing three elements, each occupying a distinct set or sets of crystallographic lattice sites, exhibits a phenomenon of vanishing electrical resistance below a critical temperature T_c, a property also earlier associated with many pure metals, binary alloys and intermetallics. GVS made significant contributions in the field of ternary superconductors, especially Chevrel phase superconductors. Ternaries are usually type-II superconductors.



Chevrel phases, A_xMoCh_8, where A is an electropositive metal with $x = 0.0$–4.0 and Ch is a chalcogenide such as S, Se and Te which constitutes a series of isostructural compounds with rhombohedral structure, have been extensively studied by GVS not only with respect to their superconducting behaviour but also to establish the coexistence of magnetic order and superconductivity, reentrant behaviour and intermediate valence. In fact, he pioneered this type of work in India in collaboration with his dedicated students and researchers from across the country. He successfully applied crystal chemistry principles to derive structure–property correlations useful for high T_c superconductors, aiming at improvements in T_c. In addition, his group was able to tailor oxide materials for use as heating elements and posistors, and improving solar energy conversion efficiency in PECs.

GVS and his group also synthesized and characterized many materials such as $A_XMo_6S_8$, ZrRuP, Pd_3Ag_2S, and $Rb_3Bi_2S_2$ to find their T_c, H_{c2} (upper critical field) and other parameters to correlate T_c with a known structure and structure-related properties. Another area of his major research effort was on synthesizing, crystal-growing, characterizing and studying the physical properties on layered transition di-chalcogenides and intercalation compounds. The physical properties include T_c, and electrochemical properties for applications as battery cathode materials.

His research group paid great attention to ABO_3-type perovskite mixed oxides. These were synthesized using complex methods and growing crystals by flux techniques in search of interesting magnetic properties and semiconductor to metal transition. These oxides were used for solar energy conversion and development of electric heating elements based on $LaCrO_3$ and posistors based on $BaTiO_3$ as part of his research.

Again for applications in solar energy conversion and battery separators, his group formulated pyrochlore mixed oxides ($A_2B_2O_7$-type), since they have interesting electrical and magnetic properties. They exhibit a wide variety of properties ranging from insulating to semiconducting and metallic behaviour and from simple paramagnetism to ferro- and ferrimagnetism. Other more complex materials include spinels AB_2O_4, garnets $A_3B_5O_{12}$ and K_2NiF_4 in addition to the above-mentioned perovskites. GVS collected a wealth of data and wrote several reviews on oxide pyrochlores which were of immense use for further improvements and practical applications.

As mentioned earlier, one of his major interests was in solar energy conversions and storage. Semiconductor-based PECs were considered to be an important class of solar energy conversion systems. He worked with different semiconductor material-based chalcogenides, pnictides and oxides such as CdSe, GaAs, $CdSnP_2$ and $SrTiO_3$. He used these materials for solar energy storage as hydrogen through photo-assisted electrolysis of water. GVS and his students contributed significantly to this area in the search and development of electrode materials and electrolyte systems.

His group also generated mixed oxides of thallium and metal-cluster compounds by synthesizing $Tl_2Mo_nO_{3n+1}$ and $Tl_2W_nO_{3n+1}$ oxides through the route of solution precipitation and high-temperature solid state reactions. Metal-cluster compounds on E-glass and their composites were studied in an elegant manner. Leaching behaviour of E-glass with acids and monitoring the changes in physical properties were also part of his many studies.

GVS and his co-workers successfully developed an indigenous technology for the formulation, fabrication and performance certification of high temperature (1700–1850°C) heating elements. These are of use in defence applications as well as in laboratories. They also successfully developed posistors based on doped $BaTiO_3$ ceramics, yet another technology-intensive project.

GVS initiated fundamental studies on ion mobility and structure–property correlations in fast ion conductors (oxides and chalcogenides) based on layer- and channel-type ($LiCoO_2$; $LiRhO_2$; $LiTiS_2$, etc.). He also initiated and worked on nuclear waste disposal using the basic principle of fixing radioactive ions by mixed oxide systems. GVS also studied Heusler alloys (1 : 1 : 1-type, PtMnSb, PdMnSn, etc.) for magneto-optic applications.

At NUS, as mentioned earlier, GVS carried out research on Li-ion battery materials. His group studied several electrode materials and made significant contributions. Some of his papers emanating from Singapore are cited as many as 800+ times. His thorough experimental study demonstrated that the so-called LNMO composition is best suited as cathode in Li-ion batteries. This composition is presently used in Li-ion batteries and his work is most widely cited.

GVS passed away on 24 December 2017 at Saltlake City, Utah, USA. He was unique, whether it was in the way he taught, guided or even dressed, not to mention the research fields he pursued.

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