

Memorial of Rustum Roy, 1924–2010

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Rustum Roy, Life Fellow of Mineralogical Society of America, passed away on August 26, 2010. He was a great champion of interdisciplinary materials research and will be missed by the worldwide scientific community. Born on July 3, 1924 in Ranchi, India, he first came to Pennsylvania State University (PSU) in 1946 to work on his doctorate in ceramics. He obtained his Ph.D. in ceramics from PSU in 1948. He had a B.Sc. (Hons) in 1942 and M.Sc. in Physical Chemistry in 1944, both from Patna University, India. He became a naturalized U.S. citizen in 1961. He was associated with PSU for about 64 years as a graduate student and faculty member. He received the Evan Pugh Chair Professorship in 1981, the highest honor at PSU. He was the founder of Materials Research Laboratory and served as its first director during 1962–1985. He also served as the first director of Science, Technology and Society (STS) Program during 1984–1990. He was associated with Arizona State University as a Distinguished Professor in the Materials Program and was associated with University of Arizona as a Visiting Professor of Medicine.

Rustum Roy, who was on PSU's faculty for about 60 years, was among the two or three leading materials scientists in the U.S. Author of 816 scientific papers, 25 patents and patents pending, and 6 books with major contributions to real science from developing the sol-gel process to glass ceramics to diamond films and nanocomposites and microwave and laser processing of materials. His first paper was in *American Mineralogist* (Roy et al., "Mineralogy and Thermal Behavior of Phosphates: I. Magnesium Pyrophosphate," 1948, vol. 33, p. 458–471). He also published another 336 papers in health and STS fields. He was the senior-most member in the U.S. National Academy of Engineering (he was elected in 1973) specializing in (ceramic) materials—today one of the hottest fields in science. He was elected as a foreign member of the Swedish, Japanese, Indian, and Russian National Academies, and "knighted" by the Emperor of Japan. He was elected Fellow of The American Association for the Advancement of Science, the American Ceramic Society, the Mineralogical Society of America, and American Physical Society. He was the founder and joint editor-in-chief, *Materials Research Bulletin*; founding editor, *Journal of Educational Modules for Materials Science and Engineering* (now called *The Journal of Materials Education*); founder and editor-in-chief, *Bulletin of Science, Technology and Society*; and founder and editor-in-chief, *Materials Research Innovations*. He received



many awards including MSA award in 1957 (national award in the Geological Sciences for the most significant research by a younger scientist) and a mineral was named after him, "rustumite".

Roy also made unique and outstanding lifetime contributions to mineralogy through hydrothermal research. Roy started to utilize high temperature-high water pressure not only to synthesize hydrated phases such as clays and zeolites, but as the only way to achieve and study equilibrium in oxide systems below about 1000 °C. He was the first to conceive of the idea of attaining thermodynamic equilibria in anhydrous materials using extremely reactive (sol-gel) starting materials, combined with the catalytic power of the high K dielectric fluid, water, retained by pressure. In their advance of hydrothermal processing, Roy (with his mentor Prof. Osborn) designed both a very simple compressor, and then modified his colleague O.F. Tuttle's, superalloy pressure vessel to make the extremely convenient rack of "test-tube" bombs. Together these innovations made "hydrothermal method for studying reactions and crystal growth" a convenient, widely used process worldwide. Roy's Penn State group also, based on earlier geochemical work started early on (1950s), expanded the concept from "hydro" (water) as the only fluid, to others, starting with CO₂ for diamond synthesis. Over the years, they used CO₂, NH₃, O₂, H₂, etc., at pressures of up to 5 kbars. Of course, the "hydrothermal" process and its new variant

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the solvothermal process, has spread worldwide and produced extraordinary science in thousands of laboratories, including Prof. Roy's own. His work was related to his emphasis on synthesis, crystal chemistry, and phase diagrams. He systematically synthesized and did the crystal chemistry on the whole clay and mica families—and started on the zeolites. The postwar binary, ternary, and quaternary diagrams on the most significant ceramic (not earth-forming systems treated by Morey et al.) systems (i.e., involving MgO, CaO, SrO, Al₂O₃, Ga₂O₃, SiO₂, TiO₂, etc.) were pioneered in Roy's laboratory.

When the history of postwar American higher education is written, Rustum Roy will be remembered as the most effective champion of interdisciplinarity and integrative learning. In materials science and engineering, the prototype of interdisciplinarity in the science disciplines, Roy not only established working models locally in both degree programs and research laboratories and led them to national prominence, but he led the campaign in the U.S. and abroad to institutionalize “materials” as a permanent part of academia. His conferences, workshops, and committees all helped, but the establishment of a new professional society—the Materials Research Society—of which he was the principal architect, proved to be the most effective strategy.

What was most interesting about Rustum Roy was the

breadth, not only of his interests, but his activities and achievements in each field. Perhaps the best way to gauge this breadth is to note the subjects of his well-known books (outside his science); science policy; sexual ethics; radioactive waste management; liturgies for small groups. He was as equally at home among the world's leading theologians, clergy, artists, and healing “gurus” as he was among scientists/engineers from industry or academe, and among social reformers or activists in entrepreneurial business innovation.

Newsweek has accurately described him as “the leading contrarian” among U.S. scientists. The U.S. House of Representatives' Committee on Science, Technology, and Research gave him its only standing ovation in 16 years after one of his testimonies. Rustum Roy was the only practicing prominent American scientist who studied and wrote critically about U.S. science policy from the inside. His criticisms of U.S. policy, regarded as far out a decade ago, are now called “prescient”. He called himself a citizen-scientist trying to be a whole person.

On a personal note, he was my mentor, colleague, friend, and father figure. I was lucky to be associated with him for most of my professional life. I will sorely miss him. He will be missed by the worldwide scientific community in addition to his wife, Professor Della M. Roy and his three sons.