This lecture will provide an overview of research activities in the area of nanostructured carbon and carbide materials used for capacitive storage of electrical energy. Electrochemical capacitors or “supercapacitors” are devices that store electrical energy electrostatically and are used in applications where batteries cannot provide sufficient power or charge/discharge rates, or when a long service life (up to 1 million cycles) is needed. Until now, their higher cost, compared to batteries, has been limiting the use of supercapacitors in household, automotive and other cost-sensitive applications. We describe the materials aspects of supercapacitor development, address unresolved issues and outline future research directions.

High surface area carbon materials are widely used as supercapacitor electrodes. Graphene, nanotubes, activated carbons, template carbons, carbon onions and carbon black are among many materials being used in supercapacitors. Extraction of metals from carbides can generate a broad range of potentially important carbon nanostructures, which range from porous carbon networks to onions and nanotubes. They are known as Carbide-Derived Carbons (CDC). The CDC structure depends on the crystal structure of the carbide precursor as well as process parameters including temperature, time and environment. Extraction of silicon, boron, aluminum, zirconium or titanium from their respective carbides by chlorine at 200–1200°C results in the formation of micro- and mesoporous carbons with specific surface area up to 3000 m²/g. CDC technology allows the control of carbon growth on the atomic level, monolayer by monolayer, with a high accuracy. It will be shown that the pore size to ion size ratio determines the efficiency of electrochemical energy storage systems. Design of supercapacitor electrodes using nanoporous carbons (3-D), graphene (2-D), carbon nanotubes (1-D) and carbon onions (0-D) will be addressed. Also, recently discovered 2-D carbides and carbonitrides known as MXenes (Ti₃C₂, Ti₂C and others) will be described.
Lyle Ramsay Dawson was a native of Illinois and received his undergraduate degree from the University of Illinois in 1932. He received his Ph.D. degree in 1935 from the University of Iowa.

Dr. Dawson served in several academic positions in Illinois, Wisconsin, Nebraska and Louisiana and also worked on the Manhattan Project as a Research Chemist and Group Leader in the Metallurgical Laboratory at the University of Chicago. In 1946, he was awarded the War Department’s Certificate of Merit and a U.S. Patent for his efforts on the Manhattan Project, which led to the discovery of a fundamental process for the extraction and purification of the elements plutonium and neptunium. He was a member of the committee that organized the Oak Ridge Institute of Nuclear Studies and was a council member of the Institute.

Professor Dawson came to the University of Kentucky in 1945 as Head of the Department of Chemistry. He provided key leadership in initiating and building the doctoral program in Chemistry at the University. For example, in his first decade in the department, he individually obtained the major portion of extramural research support. During his twenty-five years with the Department, he held contracts for fundamental chemical research with the U.S. Army, the National Science Foundation and the Atomic Energy Commission.

He directed or co-directed seventeen Ph.D. dissertations and nine M.S. theses. He was a talented research director and had a special ability to imbue his students with a concise, clear and complete scientific writing style. He published more than fifty research papers dealing with the chemistry of nonaqueous solutions and coauthored a reference book on the subject.

Dr. Dawson was a master teacher both in the classroom and in less formal conferences and discussions. His leadership and mentoring led many graduate teaching assistants and junior faculty members to become more effective teachers. His uncompromising devotion to high achievement standards in course-work, research, education and training set the tone for our department for years to come.

Another significant contribution to the Department was Professor Dawson’s indefatigable advocacy for a new chemistry building. His leadership in soliciting and designing a replacement for the former chemistry building, Kastle Hall, culminated in the opening of the current Chemistry-Physics Building in 1963.

He also served the campus community in other ways. Dr. Dawson was elected a Distinguished Professor in the College of Arts and Sciences in 1954–1955, and was appointed to the rank of Distinguished Professor in the field of Physical Chemistry by the University of Kentucky Board of Trustees in 1956. He served as Acting Dean of the Graduate School in 1954–1955, 1956 and 1960–1961.

Dr. Dawson’s contributions outside the University were well recognized. He was a Fellow of both the American Institute of Chemists and the American Association for the Advancement of Science. He was a member of the American Chemical Society, Electrochemical Society, Sigma Xi, Omicron Delta Kappa, Alpha Chi Sigma and Kappa Delta Pi, serving leadership roles in each of these organizations. He served several times as a Tour Lecturer and Visiting Scientist under the sponsorship of the American Chemical Society. He was also active in a variety of other nonacademic organizations.

Dr. Dawson’s twenty-five years in the department represent a truly outstanding combination and balance of administrative leadership, teaching, research and service. Although Dr. Dawson passed away in 1976, his impact on the department continues to this day as we continue our evolution into a top-twenty research institution. The endowment of the Lyle Ramsay Dawson Lecture Series by his beloved daughter, Venita Dawson Curry, permits us to rejoice in this legacy and to continue our tradition of world-class chemical research.