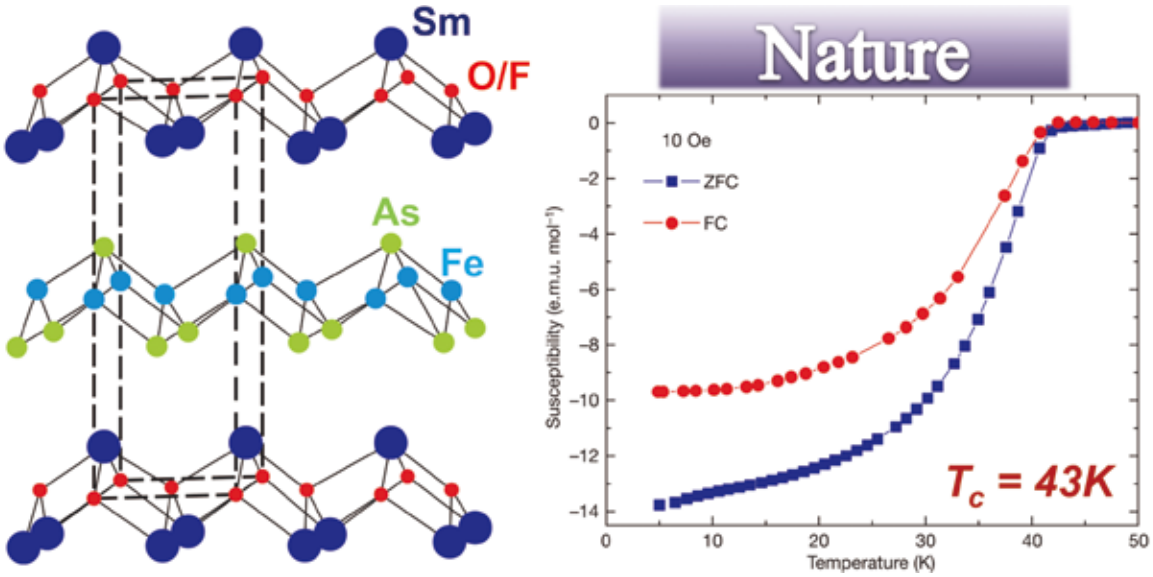
Superconductivity and Nanomaterials

In the field of superconductivity, CAS scientists successfully solved a series of theoretical and experimental issues. Early 2008, a group led by Prof. CHEN Xianhui at the University of Science and Technology of China (USTC) announced their successful identification of superconductivity with a critical temperature (T_c) of 43 kelvin (-230.15 °C) in the samarium oxygen fluorine iron arsenide ($Sm_{1-x}O_xF_xFeAs$), exceeding the McMillan Limit (39 kelvin) and marking the discovery of a non-cuprate unconventional high-temperature superconductor. The relevant research papers authored/co-authored by his group have so far been cited by peer scientists for more than 1200 times, ranking the first in the field of physics over the period from 2002 to 2012. This achievement was selected by *Science* into the top 10 S&T advances of the year 2008, and evaluated by the American Physical Society (APS) as one of the most important events in physics of the year 2008 and recognized by the European Physical Society as "The Best of 2008". Also it was voted into the top 10 news of the year 2008 on basic research of China. Together with their Chinese colleagues, the team triggered a new wave of enthusiastic explorations in the field, succeeding the discovery of cuprate superconductors.

After that, the team further explored into novel high-T_c superconducting materials and made a series of far-reaching findings. They discovered a new family of FeSe-based high-T_c superconductors whose critical temperatures could be raised to over 40 kelvin. This has inspired further explorations in similar novel superconductors. Also, they successfully identified superconductivity at 5 kelvin in alkali-metal-doped phenanthrene, opening a new research field for organic hydrocarbon superconductors. In addition, the USTC team also made important progress on experimentally exploring the mechanism of superconductivity, drawing wide attention in community.



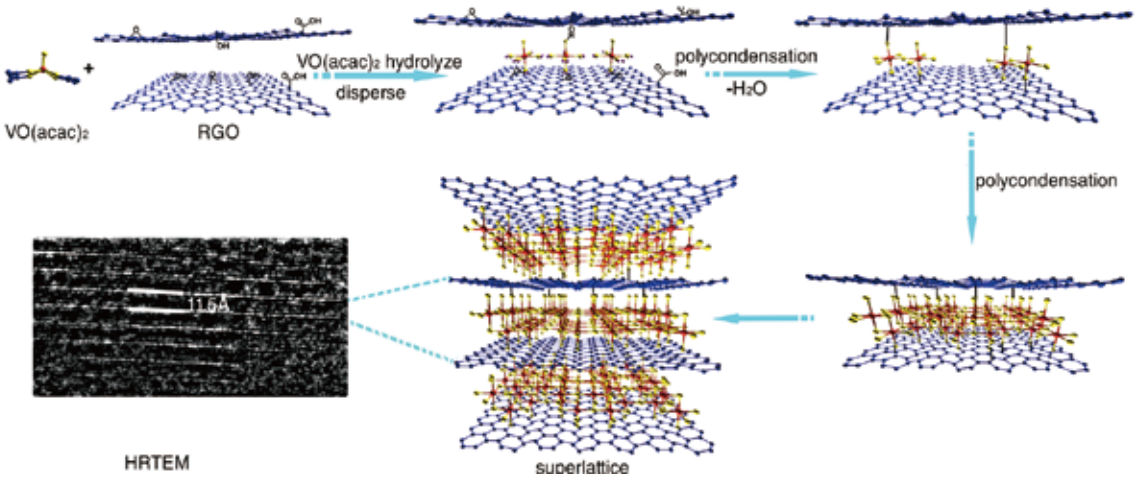
The USTC team led by Prof. CHEN Xianhui successfully breaks McMillan Limit (39 kelvin) of conventional superconductors in $Sm_{1-x}O_xF_xFeAs$ with T_c = 43K. ((Image by courtesy of Prof. CHEN)

Due to his outstanding contributions in the field of novel superconducting materials, Prof. CHEN Xianhui shared the Bernd T. Matthias Prize of 2015 together with CAS Member Prof. ZHAO Zhongxian from the CAS Institute of Physics and Prof. Zachary Fisk from USA. Aimed at promoting research in superconducting materials, this prize recognizes the best innovations in this field all over the world. The team's work also won the collective recognition award for outstanding achievement in science and technology from the Qiu Shi Science & Technology Foundation and the First Prize from the National S&T Awards for Natural Sciences.

The team led by Prof. YU Shuhong successfully developed a new method for macroscopic-scale template synthesis of carbon nanofiber hydrogels/aerogels, and ultralight, flexible and fire-resistant carbon nanofiber aerogels from bacterial cellulose. (Image by courtesy of Prof. YU)

In the field of nanomaterials, USTC also made great achievements. Particularly, a team led by Prof. YU Shuhong at the university has focused on developing new methodologies for controlled, large-scale synthesis of important nanoscale building blocks with different dimensionalities. Over the five years from 2010 to 2015, they made breakthroughs in the following areas: methodologies for controlled synthesis and mass preparation of a series of 1D nanowires and 2D nanofilms, controlled assembly of nanoscale building blocks, and preparation of macroscopic assemblies, preparation of novel nanomaterials for energy conversion and storage, and basic characteristics of nanodevices. So far they have succeeded in large-scale synthesis of some nanomaterials, including nanocrystalline silicon, sub-kilogram-scale tellurium nanowires, 10-litre-scale carbon nanofiber gels, carbon-transition metal dichalcogenide hybrids, and organic metallic framework nanowires.

Prof. YU Shuhong and colleagues won a Second Prize from the National S&T Awards for Natural Sciences in 2010 for his outstanding contributions to construction of inorganic functional materials with complex morphology and structure, and research in self-assembly mechanism and characteristics, and also the First Prize from the S&T Awards for Natural Sciences of Anhui Province in 2014; and Prof. XIE Yi, an important player of the nanomaterial research team at USTC, also won a Second Prize from the National S&T Awards for Natural Sciences in 2012, due to her innovative contributions to smart construction of inorganic functional nanomaterials oriented at characteristic structures.



The team led by Prof. XIE Yi, a key player in the research, made important progress in developing a spatially confined reaction strategy to synthesize flexible freestanding graphene-based superlattice. (Image by courtesy of Prof. XIE)