Materials Science and Engineering Industry

National Inventors Hall of Fame®

It is known that Thomas Edison tested 1,600 different materials to be used as the filament in the incandescent light bulb. Now light bulbs are being replaced by light-emitting diodes (LEDs), which provide light to buildings, streets, cars, and to developing countries that otherwise do not have access to electric light.

The state of the materials science industry is rapidly growing. According to *The Economist's 2015 Technology Quarterly* issue, materials scientists alerted the media to more than 100 significant discoveries in the month of November 2015 alone. Ranging from how cars are made to changing the way of X-rays, the materials science industry is making strides and looking to change the world.

As materials science departments at colleges and universities continue to grow and attract more students, we will continue to look to this industry to advance American ingenuity and drive us into the new age. Change-agents, like Edison, have directly impacted the industry and provide inspiration for future generations. This year, the National Inventors Hall of Fame will induct four innovators in materials science and engineering.

J. Roger P. Angel

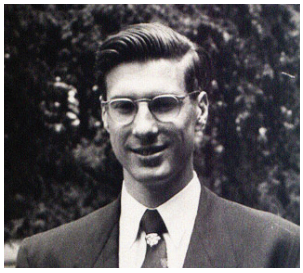
Roger Angel designs and builds optics for astronomical research and recently for more efficient and economical solar energy. He is best known for making very large and lightweight mirrors for astronomical telescopes. These are honeycomb sandwich structures cast in one piece of glass and polished with a deeply curved, highly aspheric surface by a unique stressed-lap method. These mirrors, made at the University of Arizona, where Angel is Regents' Professor of Astronomy and Optical Sciences, are used in many of the world's leading observatories.

Angel developed another way to improve telescopes by making their smaller secondary mirrors of very thin glass. In use, these mirrors are rapidly bent into different shapes to correct for constantly changing atmospheric blurring. The resulting sharpened images are used, for example, to find and study the planets of other stars.

In another technique developed by Angel, light from many distant galaxies is transmitted by optical fibers for simultaneous spectroscopic analysis. Using this technique, astronomers found that the universe is being pushed apart by dark energy.

Recently, Angel has turned his attention to inventing optics for solar energy collection. One approach employs large glass solar dish reflectors and secondary optics to concentrate sunlight onto small multijunction PV cells with twice the conversion efficiency of conventional PV panels. Angel founded the company REhnu to commercialize this technology.

Born in England, Angel earned B.A. and Ph.D. degrees from Oxford University. He is a member of the National Academy of Sciences, a Fellow of the Royal Society, a MacArthur Fellow and a 2010 Laureate of the Kavli Prize in Astrophysics.



Roger Bacon

In 1958, Roger Bacon's chance discovery revolutionized industries and became a multibillion-dollar a year industry. While measuring the triple point of graphite (the temperature and pressure where solid, liquid and gas are in thermodynamic equilibrium) in a carbon arc furnace, Bacon observed whiskers of perfect graphite inside the resulting stalagmite-like deposits. These whiskers, up to an inch long and only a tenth the diameter of a human hair, launched the age of high-performance carbon fibers.

In fibrous forms, carbon and graphite are the strongest and stiffest materials for their weight that have ever been produced. Bacon demonstrated fibers with remarkable tensile strength (the amount of pulling force applied before failure) and extraordinary Young's modulus (a measure of a material's stiffness). Bacon and colleagues at Union Carbide's Parma Technical Center began researching applications for his breakthrough after his discovery.

During the 1960s, the U.S. Air Force supported Union Carbide's research into carbon fibers, recognizing their use in a new generation of stiff, high-strength composites for rocket nozzles, missile nose tips, and aircraft structures. Carbon fibers quickly became and remain important aerospace materials. Military aircraft such as the F-22 Raptor utilize carbon fibers for the fuselage frame, doors, spars on wings and skin panels.

Applications have expanded into civil engineering, sports, specialty automobiles, and many consumer products. Bacon's pioneering work in graphite whiskers has also been cited as the forerunner of multi-walled carbon nanotubes.

Bacon earned his B.A. from Haverford College and his Ph.D. from Case Institute of Technology, which later merged with Western Reserve University to become Case Western Reserve University.

William J. Sparks & Robert M. Thomas

William J. Sparks & Robert M. Thomas co-invented poly-isobutylene-co-isoprene, commonly known as butyl rubber, while conducting research at Standard Oil Company's laboratory in Linden, New Jersey. In 1937, Thomas and Sparks experimented with another Standard Oil product, Vistanex, which had rubber-like properties. They mixed a batch of Vistanex in a washing machine, then added a small amount of butadiene. Smoke filled the air as the spin cycle finished, revealing the pair's first batch of butyl rubber.

Butyl rubber — as strong as natural rubber, resistant to oxidation and possessing unusually low gas permeability — was used by the U.S. government during World War II and commercialized in 1943. The first major use for butyl rubber was the manufacture of tire inner tubes. Butyl rubber and its modifications are still used for tire inner tubes, motor mounts, sealants, tank and pond liners and similar applications. Its impermeability to air makes it useful for protective gloves, sealants and adhesives, bladders in sporting balls, and more, including a food safe version for chewing gum. Butyl rubber is also good for damping vibrations and can be flexed back and forth without cracking. It resists ozone, aging and weathering effects and can also be chilled to a fairly low temperature without becoming brittle.

Sparks received his B.A. and M.A. from Indiana University and his Ph.D. from the University of Illinois. In addition to Standard Oil, he worked with the U.S. Department of Agriculture and Esso Research and Engineering, and earned 145 patents for materials including new fuels, gasoline additives, propellants, encapsulated oxidants, asphalt additives, and food-wrapping films.

Thomas received his B.S. in chemistry from Virginia Tech. He joined Standard Oil in 1929 and retired in 1965. During his career, he earned 75 patents and directed the work of several notable polymer scientists.