

Material economies

10,500 BCE The Jomon people in Japan use pottery (the transformation of clay into hardened objects through the application of heat)
5000 BCE Weaving in the form of basketry practiced in central Europe
4000 BCE Papyrus paper appears in Egypt: the papyrus plant's central pith is cut into thin strips, pressed together, and dried to form a smooth, thin writing surface
4000 BCE Adhesives made from tree sap and used to repair clay pots
4000 BCE Iron used in Egypt and Sumer
3000 BCE Copper metallurgy begins and is first used for ornamentation
3000 BCE Bronze used in Greece and China
3000 BCE Cotton in use in India
2500 BCE Silk developed in China
2500 BCE The first writing inks used in Egypt and China
2000 BCE The Chinese make and use pottery
1600 BCE The Hittites develop crude iron metallurgy
1500 BCE Straw used to reinforce mud bricks in Egypt and Israel
1300 BCE The first steel invented when iron and charcoal are combined
1200–600 BCE Iron replaces the use of bronze
1000 BCE Pewter in use in China and Egypt
1000 BCE Parchment (the processed skin of animals) invented in Pergamum, Greece
900 BCE Glass production begins in Greece and Syria
400 BCE Democritus determines that if things move, then there must be space between them, which leads to the first theory of an atom

By convention there is color, by convention sweetness, by convention bitterness, but in reality there are atoms and space — Democritus

300 BCE Molded glass invented in Alexandria, Egypt
2 BCE The Romans add volcanic ash to lime to produce a more resistant concrete, called *pozzolanan*
105 Chinese court official Tsai Lun creates the first modern paper (as opposed to Egyptian papyrus) by mixing hemp, mulberry bark, and rags with water
618 First porcelain produced in China
748 Printed newspapers appear in Peking, China
1150 First paper mill appears in Europe, built by Arabs in Xativa, Spain
1224 The first glassblowers' guild forms in Venice
1450 Johannes Gutenberg invents his method of printing from raised, movable type with oil-based inks, used without significant change until the 20th century
1450 Venetian glassblowers invent *cristallo*, a clear, soda-based glass
1486 Juliana Berners's *Book of Hawking, Hunting, and Heraldry* becomes the first color printed book in England
1575 The first European porcelain made in Florence, Italy
1590 Glass lenses developed in the Netherlands for use in microscopes and telescopes
1600 Glass widely used in England for windows and bottles
1612 Antonio Neri publishes *L'Arte Vetraria*, the first manual of glass making, in Florence
1674 George Ravenscroft patents crystal glass in England

1698 Paper manufacturing begins in North America
1735 Naturalists Charles Marie de la Condamine and François Fresneau describe natural rubber following an expedition to South America
1738 William Champion patents a process for the production of metallic zinc by distillation from calamine and charcoal
1740 The development of the crucible (casting) process for steel production yields a form of steel with fewer impurities and more uniform in composition than any previously produced
1750 Glue or adhesive, manufactured from animal hides, receives a patent in Britain
1756 English Engineer John Smeaton formulates the best mortar for underwater construction by adding limestone to clay while building the third Eddystone lighthouse in the English Channel
1770 English chemist Joseph Priestley gives rubber its name when he finds it is helpful in rubbing out pencil marks
1781 Swedish chemist Carl Wilhelm Scheele isolates tungstic acid, leading to the metal tungsten's isolation by Spanish chemists in 1783
1797 French chemist Nicolas-Louis Vauquelin discovers chromium
1800 Josiah Spode introduces the first bone china, a hybrid hard-paste porcelain containing bone ash, in England
1810 Englishman Peter Durand receives a patent for the tin can
1823 Scottish chemist Charles Macintosh invents a method for making waterproof garments by using rubber dissolved in coal-tar naphtha and thereby cementing two pieces of cloth together
1824 Joseph Aspin develops Portland cement, the most common cement used today
1825 Hans Christian Orsted produces metallic aluminum
1828 Corrugated galvanized iron first formed in the U.K.
1830 Michael Thonet produces laminated and steam-bent wood chairs in Europe
1831 Styrene isolated from storax, a natural balsam
1839 Charles Goodyear discovers vulcanization process for curing rubber
1855 Georges Audemars invents the first crude "artificial silk," later named rayon
1856 W. H. Perkin produces the first artificial dye from aniline
1860 Frederick Walton patents the process for making linoleum
1862 Alexander Parkes exhibits Parkensine, the first human-made plastic, made from cellulose nitrate, at the Great Exhibition of 1851 in London
1869 Dmitry Mendeleev develops the periodic table of elements
1869 Celluloid, developed from cellulose nitrate and camphor, becomes the first synthetic plastic material to be used widely
1873 Levi Strauss and Nevada tailor David Jacobs co-patent the process of putting rivets in pants for strength—the official birth of blue jeans
1875 Andrew Carnegie opens the J. Edgar Thomson Steel Works near Pittsburgh, the first steel mill in the U.S. to use the Bessemer process, a method of removing impurities from molten pig iron to make steel

Farewell, then, Age of Iron; all hail, King Steel — Andrew Carnegie

1883 Charles Fritts constructs the first solar cells by coating the semiconductor selenium with an ultrathin layer of gold
1883 English chemist and physicist Sir Joseph Swan produces the first synthetic fibers by squeezing nitrocellulose through tiny holes

1884 William Tilden synthesizes isoprene by decomposing turpentine vapors, laying the foundation for the production of synthetic rubber

1885 German chemist Clemens Winkler discovers the element germanium, the only element named after a country

1887 Reverend Hannibal Goodwin invents celluloid film for photography

1887 Adolf Fick develops the first contact lens, made of glass, to correct irregular astigmatism

1892 French engineer François Hennebique patents a construction system using reinforced concrete, still in use today

1894 Charles F. Cross and Edward J. Bevan receive a patent for cellulose acetate used in industrial production

1902 Auguste Verneuil develops a process for making synthetic gemstones

1904–11 Stainless steel developed in England, the U.S., and Germany

1905 Albert Marsh invents chromel, an alloy of nickel and chromium that is used as a heating element in many appliances

1908 Jacques E. Branderberger invents cellophane, initially in an attempt to create tablecloths resistant to wine spills

1908 Fritz Haber and Carl Bosch develop a method for synthesizing ammonia, used to produce fertilizers as well as explosives

1909 Édouard Bénédictus patents the first safety glass, a layer of celluloid bonded between two layers of glass

1909 Leo Baekeland develops the production method for Bakelite, the first plastic made from synthetic polymers

I was trying to make something really hard, but then I thought I should make something really soft instead, that could be molded into different shapes. That was how I came up with the first plastic. I called it Bakelite — Leo Baekeland

1910 American chemist Matthew A. Hunter prepares titanium

1911 Dutch physicist Heike Kamerlingh Onnes discovers superconductivity

1913 Neils Bohr publishes his model of the atomic structure

1916 Keds brand of shoes are introduced: the first shoes with rubber soles and the first to be called sneakers (because the new soles make them quiet)

1918 Jan Czochralski invents crystal pulling, a method for growing single crystals of semiconductors, metals, salts, and synthetic gemstones

1922 German chemist Hermann Staudinger proposes the structure of polymers as consisting of long chains of atoms held together by covalent bonds

1924 Corning Glass Works introduces Pyrex as a glass more resistant to breaking

1924 Sakichi Toyoda invents an automatic loom that ceases production when it detects an error; the profits from the sale of the patent later help his son Kiichiro Toyoda found Toyota Motor Corp.

1927 While working for the B. F. Goodrich Co., Waldo Semon develops plasticized PVC (polyvinyl chloride)

1929 Physicist Georges Friedel discovers products that can be presented in a stable state between solids and liquids (liquid crystals)

1930 Neoprene, the first mass-produced synthetic rubber compound, invented

1930 Samuel Kistler invents Aerogel (99.8% oxygen and 0.2% silica dioxide), the world's lightest known solid material

1930 Chlorofluorocarbons (CFCs), also known as Freons, introduced as refrigerants

1931 Polystyrene (a strong, inexpensive thermoplastic resin) begins to be manufactured

1935 A DuPont research group produces nylon

1936 German company Rohm and Haas commercializes Plexiglas, an acrylic glass

1937 Otto Bayer prepares the first polyurethanes, a class of polymers widely made into flexible and rigid foams, veneers, and fibers

1938 Owens-Corning Fiberglas Corporation begins commercial production of Fiberglas

1938 DuPont chemist Roy Plunkett discovers Teflon (polytetrafluorethylene)

1939 Imperial Chemical Industries produces industrial polyethylene, used during World War II as an insulator for radar cables

1943 Dow Corning Co. begins industrial production of silicones

1944 Ray McIntire at Dow Corning Co. invents Styrofoam

1946 William Kroll proves titanium can be commercially produced by reducing titanium tetrachloride with magnesium in the Kroll process, still in use today

1947 Epoxy resins introduced commercially as adhesives in the U.S.

1947 Commercial application of a piezoelectric ceramic, barium titanate, used as a phonograph needle

1947 The first transistor invented, produced using germanium as the semiconductor

1947 Earl Silas Tupper introduces Tupperware to the market

1948 Swiss engineer Georges de Mestral invents Velcro

1948 Kevin Tuohy develops plastic contact lenses

1950 New interest in composite materials (fiber-reinforced metals, polymers, and ceramics) spawned by demand for lighter and more rigid material for aerospace structures and electronics

1950 The U.S. Department of Defense offers incentives to encourage titanium production to answer the need for higher strength-to-weight ratios in jet aircraft structures and engines

1951 Erwin Müller invents the field ion microscope, through which individual atoms can be seen for the first time

1952 The LD Process, the first basic oxygen steelmaking process, developed in Austria

1953 Karl Ziegler and Giulio Natta discover the titanium-based Ziegler-Natta catalyst, greatly improving the strength of plastics

1953 General Electric chemist Daniel Fox develops Lexan polycarbonate resin, widely used to make bullet-resistant glass, compact discs, DVDs, and medical tools

1953 Dow Chemical introduces Saran Wrap

1954 The first solar battery invented at Bell Laboratories

1954 Fiber optic technology first announced

1955 GE Research Laboratory invents the first reproducible process for making synthetic diamonds

1956 Patsy Sherman and Samuel Smith of 3M Co. coinvent Scotchgard fabric and material protector

1959 Sir Alastair Pilkington patents the float glass process

1960 Acrylic paint available commercially

1960 Theodore Maiman constructs the first successful laser

1960 U.S. Food and Drug Administration (FDA) approves Teflon for use as a nonstick cookware surface

1961 DuPont introduces Tyvek

1961 Proctor & Gamble Co. introduces Pampers disposable diapers, composed of fluff pulp with a rayon topsheet and polyethylene back sheet

1961 Japanese scientist A. Shindo produces the first carbon (graphite) fiber

1962 DuPont commercializes elastane fiber (spandex) under brand name Lycra

1964 Stephanie Kwolek invents Kevlar, a fiber claimed to be five times stronger than steel
1965 Monsanto Co. invents the first artificial grass, originally sold under the name Chemgrass, but renamed AstroTurf after its use at the Houston Astrodome in Texas
1968 RCA Co. introduces liquid crystal display (LCD)
1969 Robert Gore invents Gore-Tex material
1970 Silicon chips used for the first time in computer memory applications
1970 Dow Corning Co. develops silica optical fibers
1970 Thermoplastic polyester introduced, including the materials Dacron and Mylar
1970 Sialon, a ceramic material for high-speed cutting tools in metal machining, created
1973 Liquid crystals appear in many objects of everyday use: watch dials, calculator screens, electronic games, and portable computers
1974 Mario Molina and Franklin Rowland publish warnings in the science journal *Nature* of damage to stratospheric ozone due to chemicals such as CFCs, widely used in aerosol spray cans
1975 Police officers in Dorset, U.K., install live fiber-optic links to replace communication systems
1977 Electrically conducting organic polymers discovered
1979 Dyneema is developed, a synthetic fiber based on ultra-high molecular weight polyethylene that is 15 times stronger than steel
1981 K. Eric Drexler puts forward the idea of molecular manufacturing systems, introducing the concept of nanotechnology, the manipulation and manufacture of materials on the scale of atoms
1985 Rice University scientists led by Harold Kroto discover Buckminsterfullerene (C₆₀), spherical molecules composed entirely of carbon and named after R. Buckminster Fuller, creator of the geodesic dome

I just invent, then wait until man comes around to needing what I've invented — R. Buckminster Fuller

1986 U.S. plastic surgeon G. Gregory Gallico begins developing synthetic skin for medical use
1987 J. Georg Bednorz and Karl Alex Müller discover superconductivity in ceramic material at temperatures higher than previously considered attainable
1989 Nigel Middleton develops Stomatex, a fabric that mimics the breathability of a leaf
1990 IBM scientists use a STM (scanning tunneling microscope) to pin single molecules to a surface, arranging 35 xenon atoms to spell the corporate logo
1990 Nanocomposite materials introduced, in which nanoparticles (clay, metal, and carbon nanotubes) act as fillers in a polymer matrix
1990 Laptop computer batteries become lighter and more efficient, due to the replacement of heavy lead-acid batteries first with nickel metal hydride and then lithium ion and lithium polymer
1990 Plastic recycling programs now common in the U.S.
1990 Two biodegradable plastics introduced: Novon by Walter Lambert and Biopol by Imperial Chemical Industries
1991 Japanese researcher Sumio Iijima at NEC Co. discovers nanotubes
1992 Fujitsu introduces the first full color plasma display panel, in which light is created by phosphors excited by a plasma discharge between two flat panels of glass
1993 Commercially viable blue LEDs (light-emitting diodes) invented by Shuji Nakamura at Japan's Nichia Corp.: these can be added to existing red and green LEDs to produce white light
1994 Silicon technology used in optoelectric devices
1995 Metal matrix composites used in spacecraft applications, such as in the Hubble Space Telescope
1996

The impact of nanotechnology on health, wealth, and the standard of living for people will be at least the equivalent of the combined influences of microelectronics, medical imaging, computer-aided engineering, and man-made polymers in the 20th century — Richard Smalley, nanoscientist and Nobel Laureate

1996 Toray Industries, Inc., designs a knotless fishing net of interconnected, twisted polyester threads, which compacts to less than 1% of its expanded width

1997 Electronic ink, which carries a charge enabling it to be updated by electronics, is developed by scientists at Massachusetts Institute of Technology

1997 The Guggenheim Museum Bilbao opens to the public, the first European building housed in titanium panels

1998 Deborah Chung at the University of Buffalo, New York, patents Smart Concrete, in which short carbon fibers are added to conventional concrete to give it the ability to detect stress

1999 Tekno Bubbles, liquid bubbles that illuminate under ultra violet light, invented

2000 Cooperative Research Centre in Australia develops affordable biodegradable plastics for food packaging

2000 Food vendors at the Sydney Olympics use only biodegradable and recyclable packaging

2001 Georgia Tech Research Corp. and SensaTex Inc. invent SmartShirt, which records heart and respiration rates, body temperature, and calories burned

2001 Wonder gel is invented, a hydrogel that can absorb most liquids and seal cracks in oil wells

2001 PPG Industries introduces self-cleaning windows

2002 Melbourne's Plantic Technologies commercializes a form of corn starch-based biodegradable plastic packaging

2002 Nano-tex LLC introduces nanotechnological, wearable fabrics, whose "nanowiskers" help repel spills

2002 NASA refines Aerogel and uses it on space shuttle missions to trap spaceborne particles traveling at high speeds and bring them back to Earth for analysis

2002 Nexio Biotechnologies researchers synthesize spider silk by coaxing mammalian cells into producing spinnable proteins by equipping them with spider silk genes

2002 Sanford Ponder invents the ICOPOD, a temporary housing shelter made from a single piece of laminated paperboard

2002 The Vacuum Distillation process of producing titanium helps reduce the cost of its production

2003 Researchers create the blackest black ever made on Earth, producing a coating that reflects 10 to 20 times less light than current materials

2003 Scientists at the University of Tokyo develop an optical camouflage system, in which a person or object wearing a special reflective material seems to disappear: a video camera records the scenery behind the subject and transmits that image to a front-mounted projector, which then displays the scene on the reflective material

2003 Robert Langer produces a biodegradable polymer scaffold, which has the potential to encourage stem cells to grow and differentiate into complex, 3-D tissues

2003 Scott White and scientists at the University of Illinois create self-healing plastic

2003 Adam Whiton and Yolita Nugent invent the No-Contact Jacket, which protects wearers by delivering an powerful but nonlethal electric shock to attackers: powered by a 9-volt battery, the jacket is made from a conductive fiber layered with waterproof nylon and lined with rubber to protect the wearer

2003 New fabrics enter the market: swimsuits made of treated salmon skin, invented by Claudia Escobar, and Luminex, a glowing fabric invented by researchers at Luminex Corp.

2004 Geoffrey Ozin leads a team of scientists at the University of Toronto who develop Synthetic Opal, a material that may be used in the manufacture of faster and smaller computer chips

2004 Sony's Librié, the first commercial product using Electronic Paper Display (a thin, light, paper-like display with high contrast and low power consumption), launched in Japan: EPD can be used for easily changeable transportation and retail signage, clock displays, and updatable newspapers

2004 The structure and method of production for bioplastics, (a form of plastics derived from plant sources, unlike traditional plastics derived from petroleum, obtained from renewable resources, and biodegradable) established

2004 Hungarian architect Áron Losonczi creates a light-transmitting concrete, embedded with an array of glass fibers

2005 Scientists at the University of Tokyo develop a pliable artificial electronic skin that can sense pressure and temperature

2005 Squid Labs develops Smart Rope, a material embedded with electrically conductive metal fibers that can sense the amount of weight it bears and alert users to a load that is too heavy

2006 Italian scientists create a solid, glasslike form of carbon dioxide by subjecting it to extreme pressure

2006 Researchers at Tufts University in Massachusetts create a nanomaterial that combines the strength of spider silk and the rigidity of silica, which could aid in the fabrication of replacement bones

2006 Researchers in South Korea and the U.S. develop electroactive paper, an ordinary cotton-based paper coated with a thin layer of gold: the paper bends when bathed in an electric field, making possible a paper airplane that flaps its wings and flies in a determined path