General Resources

These general materials science resources support NOVA's four-part *Making Stuff* series and include resources specific to each episode, and each of the four demonstrations and four activities.

BOOKS

Amato, Ivan. *Stuff: The Materials the World Is Made Of*. New York, NY: Basic Books, 1997.

Ball, Philip. *Made to Measure: New Materials for the 21st Century*. Princeton, NJ: Princeton University Press, 1999.

Woodford, Chris. *Cool Stuff and How It Works* (three-book series). New York, NY: Dorling Kindersley, 2005, 2007, 2008.

ORGANIZATIONS

Association of Science-Technology Centers (ASTC)
astc.org
The umbrella organization for science centers and museums has a useful resource center and publications for improving demonstrations and exhibits.

ASTM International (ASTM)
astm.org
Originally known as the American Society for Testing and Materials, ASTM International sets technical standards for materials, products, systems, and services.

Materials Research Society (MRS)
mrs.org
"The materials gateway" site for members of the materials science community includes pages and links for NOVA's *Making Stuff* series and other partnership outreach programs.

Nanoscale Informal Science Education (NISE) Network
nisenet.org
Here's where scientists and informal science educators join forces to provide, access, and exchange resources about the science of the very small. The site includes current nanoscale research, an online collection of educational resources (exhibits, programs, activities, demonstrations, and so on), scientific images, community forums, events, and links.

National Nanotechnology Infrastructure Network (NNIN) Education Portal
nnin.org/nnin_edu.html
K–12, university, and community educational materials on nanotechnology products, careers, natural and artificial structures, the nanoscale, and more. Nanooze is an online children's science magazine available in English, Spanish, and Portuguese.

National Science Foundation's Materials Research Science & Engineering Centers (MRSECs)
mrsec.org
The Education Outreach page lists programs, contacts, events, workshops, and links to more than 30 university members of MRSEC.

WEB SITES

AZoM: The A to Z of Materials
azom.com
Search the database for technical and general articles and videos about any of the materials mentioned in the *Making Stuff* episodes or guides.

DemoFiles: The Science Demonstration Cookbook
demofiles.org
Online database of demonstrations contributed by teachers and museum educators (including one for walking on oobleck), tips and tricks, and a forum for sharing ideas.

NOVA's Making Stuff *Web site*
pbs.org/nova/makingstuff
Don't miss the Inside NOVA blog: Adventures in "Making Stuff." Go behind the scenes with host David Pogue and the crew as they film the series.

Science Saturdays
sciencesaturdays.org
Free streaming or downloadable videos of science talks aimed at a general audience of kids. "Strange Stuff: From Smart Materials to Nanotechnology," "Metals with Memories," "If the Walls Could Think: Smart Materials in Buildings," and "Batteries, Transportation, and Climate Change" relate to *Making Stuff* activities. Go to strangematterexhibit.com/demoworks_final.pdf to download *Demoworks*, a collection of 43 quick demonstrations prepared by materials scientist Ainissa Ramirez, the host of Science Saturdays.

Strange Matter Exhibition
strangematterexhibit.com
The Web site for a traveling exhibition about materials science features interactive online modules that invite visitors to "Zoom Inside Stuff, Transform Stuff, Crush Stuff, and Improve Stuff." This site also provides family and teacher resources.

University of Wisconsin-Madison MRSEC
mrsec.wisc.edu/Edetc
The focus is nanotechnology and advanced materials. The education program includes several guides with resources and links, topic-specific activities with online training videos for demonstrators, a board game and a quiz game, and a video lab with how-to clips for working with advanced materials.

Making Stuff: Stronger

BOOKS

Eberhart, Mark. *Why Things Break: Understanding the World by the Way It Comes Apart*. New York, NY: Three Rivers Press, 2003.

Gordon, J.E. *The New Science of Strong Materials or Why You Don't Fall Through the Floor*. Princeton, NJ: Princeton Science Library, 2006.

ARTICLES

Hazlewood, Kelsey. "Roundup: Bulletproof Vests." *Wired* magazine, February 22, 2010. Available online at wired.com, along with a video of a product test.

Keim, Brandon. "Carbon Nanotube Muscles Strong as Diamond, Flexible as Rubber." *Wired* magazine, March 19, 2009. Online version includes scientist Ray Baughman's images and videos.

WEB SITES

DuPont: Welcome to Kevlar®
www2.dupont.com/Kevlar/en_US
The manufacturer explains the product, technical specs, and many uses and applications of Kevlar®.

National Highway Traffic Safety Administration: Crashworthiness Research
nhtsa.gov/Research/Crashworthiness
A compilation of reports from studies of crashworthiness of vehicles including school buses.

Space Elevator video
pbs.org/wgbh/nova/space/space-elevator.html
NOVA scienceNOW explores how carbon nanotubes could provide the lightweight strength needed to form a miles-long tether into orbit.

Demonstration: Breaking Point: Testing Tensile Strength

WEB SITES

Michigan Tech's Virtual Tensile Test
mse.mtu.edu/outreach/virtualtensile/index.htm
Informational site with diagrams, charts, and a video of fiberglass, Kevlar®, and carbon fiber tensile tests.

MicroWorlds: What Is Kevlar® Made Of?
lbl.gov/MicroWorlds/Kevlar/KevlarClue1.html#Activ1Return
Tutorial about what makes Kevlar® strong on a molecular level is aimed at middle school and above.

The Wonders of Spider Silk
earthlife.net/chelicerata/silk.html
Facts about and images of spiders and their silk—one of nature's strongest threads.

Making Stuff: Smaller

WEB SITES

"Cancer Nanotech" interactive
pbs.org/wgbh/nova/body/cancer-nanotech.html
Based on one of several NOVA scienceNOW segments about nanotechnology.

Microchip Clips videos
thetechvirtual.org/projects/microchip-clips
The Tech Museum of San Jose, California, held a contest to create the best two-minute video about microchips.

"Nanotechnology Takes Off" video
kqed.org/quest/television/view/189
This Quest multimedia program includes a downloadable educator guide.

"Talking Nano"
talkingnano.net
Six DVDs address materials sciences issues. Chaptered and keyed to standards. Also available in 10-minute segments on youtube.com/nanonerds, which includes talks, demos, nano research and newscasts.

"When Things Get Small" video
ucsd.tv/getsmall/
Whimsical, half-hour romp through nanoscience concepts produced by University of California Television. Portuguese and Spanish subtitles available.

"Zoom Into" video series
dailymotion.com/user/Weird_Weird_Science
In one continuously increasing close-up, each narrated video zooms into a material (steel, plastic, carbon fiber, concrete, and so on) to the atomic scale—and beyond.

Demonstration: Nanowires and the Ever-Shrinking Microchip

BOOKS

Brady, Susan and Willard, Carolyn. *Microscopic Explorations: Grades 4–8*. GEMS (Great Explorations in Math and Science) series. Berkeley, CA: Lawrence Hall of Science, 1998.

Broll, Brandon. *Microcosmos: Discovering the World Through Microscopic Images*. London: Firefly Books, 2007.

WEB SITES

Institute for Research in Materials (IRM) at Dalhousie University
irm.dal.ca/Image%20Gallery
Scanning electron microscope (SEM) image gallery.

Materials Research Society's "Science as Art" Images
mrs.org/s_mrs/doc.asp?CID=1803&DID=171434
Downloadable color images on micro to nano scale.

Microscopy Society of America
microscopy.org/education/projectmicro
This nonprofit group teamed up with the Lawrence Hall of Science to produce Project MICRO (Microscopy In Curriculum–Research Outreach), an effort to get microscopist-volunteers into classrooms nationwide.

Molecular Expressions: Chip Shots Gallery
micro.magnet.fsu.edu/chipshots/index.html
"Microprocessors under the Microscope" is one of a dozen online image galleries. There's also an extensive primer on microscopy and a virtual microscope Java applet. The "Secret Worlds: The Universe Within" page shows incremental images in powers of 10 from galactic scale down to quarks.

Nanozone
nanozone.org
Lawrence Hall of Science's exhibit-based Web site for kids features informative cartoon interactives about nanotechnology (what it is, how small it is, who works on it, and why it's important). A black-and-white scanning electron microscope (SEM) image gallery reveals everyday objects in super close-up.

National Center for Learning and Teaching in Nanoscale Science and Engineering (NCLT)
nclt.us
Host site of the NanoEd Resource Portal (nanoed.org), a collection of lessons, online learning tools, simulations, scientific papers, workshops, and events prepared for the nanoscale science and engineering education (NSEE) community.

Making Stuff: Cleaner

BOOKS

Emsley, John. *A Healthy, Wealthy, Sustainable World*. London: Royal Society of Chemistry, 2010. See Chapters 4 (biofuels), 5 (plastics), and 6 (cities).

Leonard, Annie. *The Story of Stuff: How Our Obsession with Stuff Is Trashing the Planet, Our Communities, and Our Health—and a Vision for Change*. New York, NY: Free Press, 2010. Project Web site: storyofstuff.com/staff.php. DVD available.

Schlesinger, Henry. *The Battery: How Portable Power Sparked a Technological Revolution*. Washington, D.C.: Smithsonian, 2010.

WEB SITES

MIT's Virus Battery
web.mit.edu/newsoffice/2009/virus-battery-0402.html
Press release, images, and downloadable article about Angela Belcher's battery built from genetically engineered viruses. Belcher is also profiled in an April 2009 *Scientific American* article, "Building Tiny Living Batteries".

Plastipedia
bpf.co.uk/plastipedia/plastics_history/default.aspx
British Plastics Federation's extensive encyclopedia of all things plastic.

Plastic Marine Debris
marinedebris.noaa.gov/info/plastic.html
How big is the plastic problem? FAQs about how plastic degrades and the Great Pacific Garbage Patch, a vast island of plastic in the ocean.

Demonstration: Instant Cheese Bioplastic

RECIPES

Acid and milk combine to produce two easy-to-make cheeses: paneer (or panir) and queso blanco. Search online for recipes and how-to videos.

ARTICLE

Dell, Kristina. "The Promise and Pitfalls of Bioplastic." *Time* magazine, May 3, 2010.
A balanced look at what "bioplastic" really means. Available online at time.com.

WEB SITES

American Chemistry Council: Plastics Division
americanchemistry.com/s_plastics/index.asp
Three hands-on plastics (HOP) science kits for grades K–4, 5–8, and 9–12 are available for sale; the free Web site offers a learning center with science information and reports about plastics and the environment.

Macrogalleria: A Cyberwonderland of Polymer Fun
pslc.ws/macrog/index.htm
Polymer games, home and school activities, experiments, demonstrations, and information aimed at children.

Worldcentric: Compostable Plastics
worldcentric.org/biocompostables/bioplastics
Science and environmental background on the biodegradability of plastics from a social enterprise whose mission is sustainability. Note: This organization funds itself by selling environmentally friendly and fair trade products.

Making Stuff: Smarter

ARTICLES

L. McDonald Schetky. "Shape-Memory Alloys." *Scientific American*, November 1979, Vol. 241, No. 5, pp 74-82.

Smart Materials
azom.com/details.asp?ArticleID=123
Definition and overview of technology and applications.

Smart Stuff
philipball.co.uk/m02_01.php
Science writer Philip Ball clearly explains what smart materials are and what they can do.

BOOKS

Benyus, Janine. *Biomimicry: Innovation Inspired by Nature*. New York, NY: Harper Perennial, 2002.

Pakhchyan, Syuzi. *Fashioning Technology: A DIY Intro to Smart Crafting*. Sebastopol, CA: O'Reilly Media, 2008. A companion *Smart Materials Kit* (available at makershed.com) provides starter materials, including Nitinol.

WEB SITES

Autoline Detroit
autolinedetroit.tv
Search the podcasts for "smart materials" to see amazing applications in the automotive industry.

Biomimicry Institute
biomimicryinstitute.org/home-page-content/home-page-content/biomimicking-sharks.html
An article on shark skin–inspired technology and other innovations in biomimicry.

Shape-Memory Alloys
smaterial.com/SMA/sma.html
Information site about how shape-memory alloys work, applications, news, links, and more.

Demonstration: Shape Shifters: Shape-Memory Alloys & Polymers

BOOK

Goodstein, Madeleine P. *Plastics and Polymers Science Fair Projects*. Berkeley Heights, NJ: Enslow, 2010.

WEB SITES

Inventables
inventables.com
Search for "shape memory" to investigate emerging and cutting-edge shape-memory materials by independent inventors, who provide specifications and suggested applications. Inventables founders Zach Kaplan and Keith Schacht also have a Ted talk (ted.com) on futuristic materials, including shape-memory plastics.

Nitinol University
nitinoluniversity.com/2010/05/nitinol-the-book-an-introduction
In addition to a reference library and fact sheets, this site features *Nitinol: The Book* by Tom Guerig and Alan Pelton.