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WEEK 2:
CAMERA BASICS



MAKING SCIENCE AND ENGINEERING PICTURES
A PRACTICAL GUIDE TO PRESENTING YOUR WORK



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autumn leaves

Frankel, F. *Envisioning Science: The Design and Craft of the Science Image*. Cambridge, MA: MIT Press, 2002.

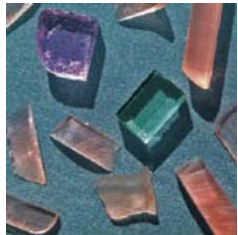


patterned spheres

G. Whitesides, Department of Chemistry and Chemical Biology; Whitesides Research Group

Harvard University

Paul, K.E., M. Prentiss, and G.M. Whitesides. "Patterning Spherical Surfaces at the Two-Hundred-Nanometer Scale Using Soft Lithography." *Advanced Functional Materials* 13, no. 4 (April 2003).



laboratory-made crystals

R. Birgeneau Laboratory
Massachusetts Institute of Technology

Gilman, J.J., ed. "Laboratory-Made Calcium Fluoride and Manganese Fluoride Crystals." *The Art and Science of Growing Crystals*. New York: Wiley, 1963.



plasmonic crystals

J. Rogers, Department of Materials Science and Engineering; Rogers Research Group

University of Illinois at Urbana-Champaign

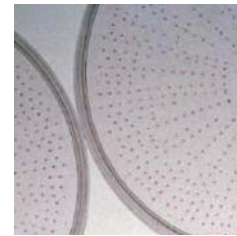
Stewart, M.E., N.H. Mack, V. Malyarchuk. "Quantitative Multispectral Biosensing and 1D Imaging Using Quasi-3D Plasmonic Crystals." *PNAS* 103, no. 46 (November 14, 2006).



microreactor

S. Ajmera, Jensen Research Group
Massachusetts Institute of Technology

Ajmera, S.K., C. Delattre, A. Martin, et al. "A Novel Cross-Flow Microreactor for Kinetic Studies of Catalytic Processes." In *Microreaction Technology [IMRET 5: Proceedings of the Fifth International Conference on Microreaction Technology]*, Springer.



E. coli patterns

E. Budrene, Department of Cellular and Developmental Biology; Budrene Laboratory

Harvard University

Budrene, E.O., and H.C. Berg. "Complex Patterns Formed by Motile Cells of *Escherichia coli*." *Nature* 349, no. 6310 (February 14, 1991).

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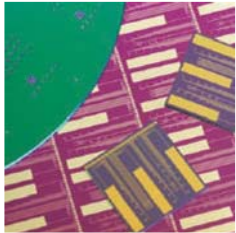
**self-
assembled
spheres**

Frankel, F., and G.M. Whitesides. *No Small Matter: Science on the Nanoscale*. Cambridge, MA: Belknap Press of Harvard University Press, 2009.



corn

unpublished

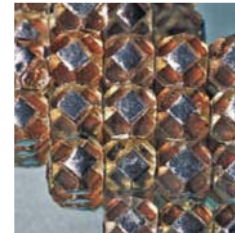


**controlled-
release
microchip**

R. Langer Laboratory;
Department of Chemical
Engineering

Massachusetts Institute
of Technology

Santini, J.T., Jr., A.C. Richards, R. Scheidt, et al. "Microchips as Controlled Drug-Delivery Devices." *Angewandte Chemie, International Edition* 39, no. 14 (July 17, 2000).

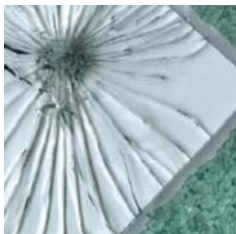


**self-assembled
structure**

G. Whitesides,
Department of
Chemistry and
Chemical Biology;
Whitesides Research
Group

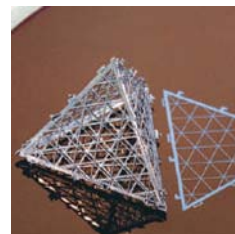
Harvard University

Gracias, D.H., J. Tien,
and T.L. Breen.
"Forming Electrical
Networks in Three
Dimensions by
Self-Assembly."
Science 289, no. 5482
(August 18, 2000).



**cropped
glass**

unpublished



**three-
dimensional
metallic
tetrahedron
microstructure**

G. Whitesides,
Department of
Chemistry and
Chemical Biology;
Whitesides Research
Group

Harvard University

Jackman, R.J., S.T. Brittain, and A. Adams.
"Three-Dimensional
Metallic Microstructures
Fabricated by Soft
Lithography and
Microelectrodeposition."
Langmuir 15, no. 3
(February 2, 1999).

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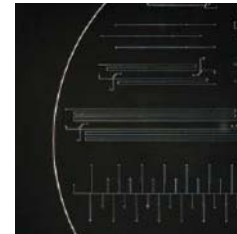
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microrotor blades

A. Epstein, Gas Turbine Laboratory, and M. Schmidt, Microsystems Technology Laboratories
Massachusetts Institute of Technology

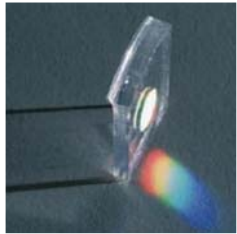
Gabriel, K. J. "Engineering Microscopic Machines." *Scientific American* 273, no. 3 (September 1995).



etched-glass wafer

D. Ehrlich, Whitehead Institute for Biomedical Research
Massachusetts Institute of Technology

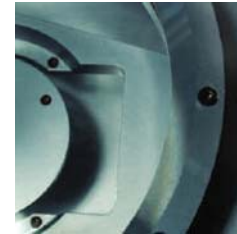
unpublished



optical grating

G. Whitesides, Department of Chemistry and Chemical Biology; Whitesides Research Group
Harvard University

Wilber, J.L., R.J. Jackman, G.M. Whitesides, et al. "Elastomeric Optics." *Chemistry of Materials* 8, no. 7 (1996).



detail of wafer chamber

M. Schmidt, Microsystems Technology Laboratories
Massachusetts Institute of Technology

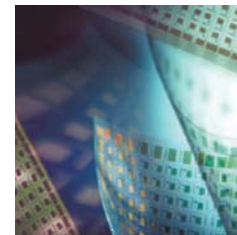
unpublished



gels

T. Tanaka, Tanaka Laboratory; Department of Physics; Center for Materials Science and Engineering
Massachusetts Institute of Technology

unpublished



flexible electronic circuit

J. Rogers, Department of Materials Science and Engineering; Rogers Research Group
University of Illinois at Urbana-Champaign

Rogers, J.A., Z. Bao, K. Baldwin, et al. "Paper-Like Electronic Displays: Large-Area Rubber-Stamped Plastic Sheets of Electronics and Microencapsulated Electrophoretic Inks." *PNAS* 98, no. 9 (April 24, 2001).

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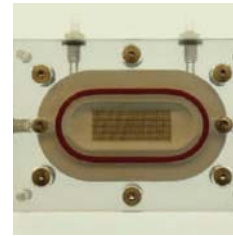


sculpture garden

Isamu Noguchi

California Scenario,
Costa Mesa, CA

Landscape Architecture
85, 1995.

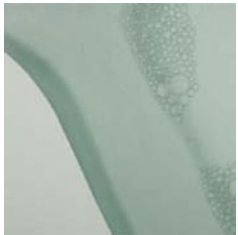


bioreactor

L. Griffith, Griffith
Laboratory

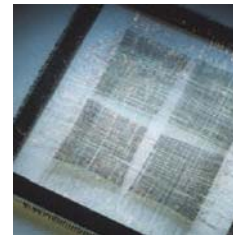
Massachusetts Institute
of Technology

unpublished



soap bubble

Frankel, F., and G. M.
Whitesides. *No Small
Matter: Science on the
Nanoscale*. Cambridge,
MA: Belknap Press
of Harvard University
Press, 2009.



**magnetic core
memory**

Frankel, F. *Envisioning
Science: The Design
and Craft of the
Science Image*.
Cambridge, MA: MIT
Press, 2002.



**micro
fermenter**

Klavs Jensen
Laboratory
Chemical Engineering

Massachusetts Institute
of Technology

Z. Zhang, N. Szita, et
al, "A well-mixed,
polymer-based
microbioreactor with
integrated optical
measurements,"
Biotech. Bioeng. 93,
(2006).



**self-assembled
polyhedra**

G. Whitesides,
Department of
Chemistry and
Chemical Biology;
Whitesides Research
Group

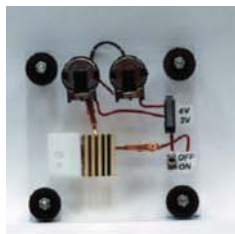
Harvard University

Gracias, D.H., J.
Tien, and T.L. Breen.
"Forming Electrical
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(August 18, 2000).

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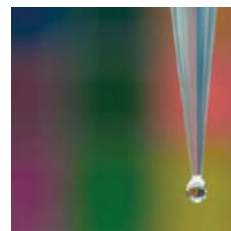
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light-emitting device

M. Rubner, Department of Materials Science and Engineering; Rubner Group
Massachusetts Institute of Technology

Handy, E.S., A.J. Pal, and M.F. Rubner. "Solid-State Light-Emitting Devices Based on the Tris-Chelated Ruthenium(II) Complex. 2. Tris(bipyridyl)ruthenium (II) as a High-Brightness Emitter." *JACS* 121, no. 14 (April 14, 1999).



water drop

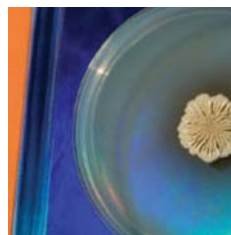
Frankel, F., and G.M. Whitesides. *No Small Matter: Science on the Nanoscale*. Cambridge, MA: Belknap Press of Harvard University Press, 2009.



copper

G. Whitesides, Department of Chemistry and Chemical Biology; Whitesides Research Group
Harvard University

Whitesides, G. M. "Copper." *Chemical and Engineering News. American Chemical Society*. 2003. <http://pubs.acs.org/cen/80th/copper.html>.



Bacillus subtilis

Roberto Kolter lab
Harvard Medical School

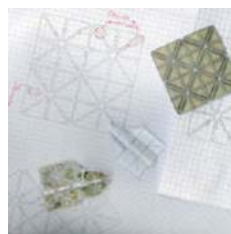
Frankel, F., and G.M. Whitesides. *No Small Matter: Science on the Nanoscale*. Cambridge, MA: Belknap Press of Harvard University Press, 2009.



polymer shapes

G. Whitesides, Department of Chemistry and Chemical Biology; Whitesides Research Group
Harvard University

Kim, E., and G. M. Whitesides. "The Use of Minimal Free Energy and Self-Assembly to Form Shapes." *Chemistry of Materials* 7 (1995).



origami robotics

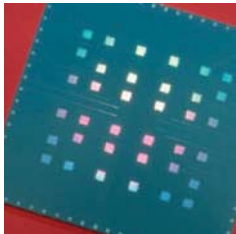
Robert Wood, School of Engineering and Applied Sciences; Wyss Institute for Biologically Inspired Engineering
Harvard University

<http://news.harvard.edu/gazette/story/2010/06/a-marriage-of-origami-and-robotics/>.

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**all-electronic
DNA array
sensor**

D. Ehrlich and P. Matsudaira, Whitehead Institute for Biomedical Research
Massachusetts Institute of Technology

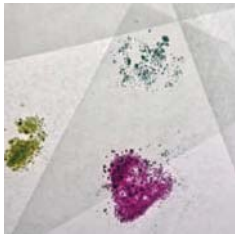
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**superhydrophobic
surface**

M. Rubner, Center for Materials Science and Engineering
Massachusetts Institute of Technology

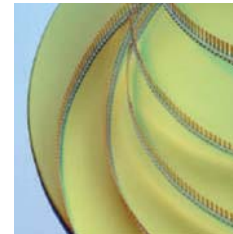
Lee, H., M. L. Alcaraz, M. R. Rubner, et al. "Zwitter-Wettability and Antifogging Coatings with Frost-Resisting Capabilities." *ACS NANO* 7, no. 3 (March 2013).



microparticles

R. Langer Laboratory; Department of Chemical Engineering

unpublished



**nickel-tungsten
alloy
sandwiched
between gold
and brass
layers**

C. Schuh, Department of Materials Science and Engineering
Massachusetts Institute of Technology

unpublished



**laboratory-
made
crystals**

R. Birgeneau Laboratory
Massachusetts Institute of Technology

Gilman, J.J., ed. "Laboratory-Made Calcium Fluoride and Manganese Fluoride Crystals." *The Art and Science of Growing Crystals*. New York: Wiley, 1963.



**high pressure
microreactor**

K. Jensen, Jensen Research Group
Massachusetts Institute of Technology

Marre, S., A. Adamo, S. Basak, et al. "Design and Packaging of Microreactors for High Pressure and High Temperature Applications." *Industrial Engineering and Chemistry Research* 49, no. 22 (November 2010).

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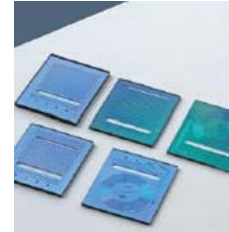
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robotic insect (RoboBees)

R. Wood, School of Engineering and Applied Sciences; Wyss Institute for Biologically Inspired Engineering
Harvard University

R. Wood, "The First Take-off of a Biologically Inspired At-Scale Robotic Insect." *IEEE Transactions in Robotics* 24 (2008)



High pressure microreactor

K Jensen, Jensen Research Group
Massachusetts Institute of Technology

Marre, S., A. Adamo, S. Basak, et al. "Design and Packaging of Microreactors for High Pressure and High Temperature Applications." *Industrial Engineering and Chemistry Research* 49, no. 22 (November 2010).



microneedles

P. DeMuth, Department of Biological Engineering; The Irvine Lab, Koch Institute for Integrative Cancer Research; The Hammond Lab
Massachusetts Institute of Technology

DeMuth, P. C., Y. Min, D. J. Irvine, et al. "Implantable Silk Composite Microneedles for Programmable Vaccine Release Kinetics and Enhanced Immunogenicity in Transcutaneous Immunization." *Advanced Healthcare Materials* 3, no. 1 (January 2014).



bakers' yeast

G. Fink, Whitehead Institute for Biomedical Research
Massachusetts Institute of Technology

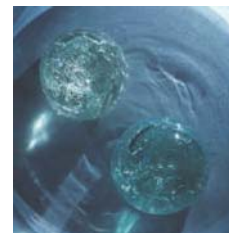
Reynolds, T. B., and G. R. Fink. "Bakers' Yeast, a Model for Fungal Biofilm Formation." *Science* 291, no. 5505 (February 2, 2001).



optical fibers

Y. Fink, Materials Science and Engineering Department; Research Laboratory of Electronics
Massachusetts Institute of Technology

unpublished



acrylamide gels

T. Tanaka, Tanaka Laboratory; Department of Physics; Center for Materials Science and Engineering
Massachusetts Institute of Technology

Alvarez-Lorenzo, C., O. Guney, T. Oya, et al. "Polymer Gels That Memorize Elements of Molecular Conformation." *Macromolecules* 33, no. 23 (November 14, 2000).

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<http://ocw.mit.edu>

Resource: Making Science and Engineering Pictures: A Practical Guide to Presenting Your Work
Felice Frankel

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