13. SHARED AND OTHER EXPERIMENTAL FACILITIES

The shared facilities are operated to encourage both hands-on research by experienced and qualified users, and as educational tools for students and researchers from other disciplines who can benefit from their use. A broad-range of facilities teaches students the skills of nanofabrication, imaging, and synthesis that they will need after graduation, and open new avenues of investigations for all disciplines. The shared experimental facilities play a special role in fostering interdisciplinary exchanges. The facilities are the natural meeting places where students from all parts of the Center learn from one another and share technical expertise.

Figure 13.1. Computer aided design of the new Laboratory for Integrated Science and Engineering (LISE) building (*left*) and the completed building at Harvard University (*right*).

New Laboratory Construction

Harvard University supported the construction of a new, 135,000 sq. ft. Laboratory for Integrated Science and Engineering (LISE). The Faculty Planning Committee viewed the construction of LISE, in close proximity to other science buildings in the north Yard, as a singular opportunity to create a research environment that will centralize major experimental facilities and foster cross-disciplinary research. The principal architect of LISE was Jose Rafael Moneo who served as Chairman of the Architecture Department of the Harvard Graduate School of Design (1985–1990). The building includes extensive vibration-free space to house the shared facilities including major cleanroom and nanofabrication facilities, advanced imaging laboratories, and facilities for materials synthesis. The building also has space for new faculty (Interdisciplinary Research Laboratories) to advance cross-disciplinary research. A third programmatic element is common space to promote collaborative exchanges. The building opened in the Summer of 2007 (Fig. 13.1). University project costs were greater than $150 M. The University is also supporting the acquisition of new instrumentation for LISE as well as the relocation of current equipment, from five different buildings where the shared facilities had been located.

Harvard University supported the construction of a new building in the north Yard at 60 Oxford Street. The top two floors, along with one floor in the adjacent Engineering Sciences Lab (ESL) at 40 Oxford Street are now home to faculty in Bioengineering. Assistant Professor Parker's laboratories have been finished in this space which has been an impetus for collaborative work in the Tools for Integrated Nanobiology Cluster, for example. The University has also recently completed the construction of new laboratory space for undergraduate bioengineering training (Fig. 13.2). These recent buildings and teaching laboratories will continue to pull the science community together, across traditional departmental boundaries and be spaces where researchers can interact in new common experimental and training facilities.

Figure 13.2. New bioengineering undergraduate teaching laboratories in Pierce Hall.

Integrated Management of Facilities and Technical Staff

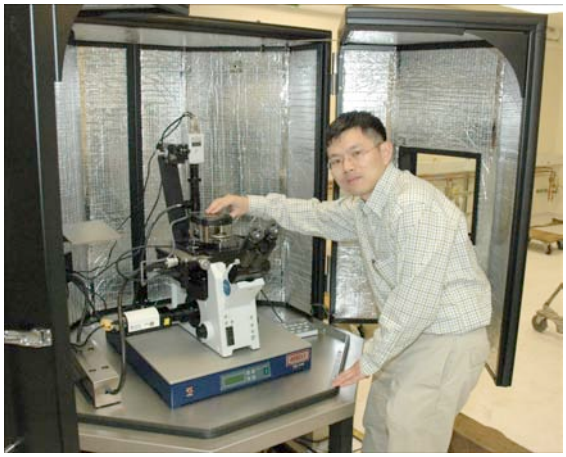


Figure 13.3. Jiangdong Deng, CNS staff member, using the new Asylum MFP-3D AFM instrument in LISE.

In January 1999 Harvard announced the commitment to launch several new interdisciplinary research centers in the sciences. The faculty had identified a strong scientific and technological need for the understanding and development of mesoscale materials and structures. This new challenge would require sophisticated facilities for imaging, nanofabrication, synthesis, and growth (Fig. 13.3). The Center for Imaging and Mesoscale Structures (CIMS) was born from this vision. Halperin, Co-PI of NSEC, was the first Scientific Director of CIMS. Harvard University supports the Center for Imaging and Mesoscale Structures (CIMS) to support research and education in the area of nanotechnology and mesoscale science. A main mission of CIMS is the provision, operation and maintenance of complex facilities for imaging and fabrication. CIMS began to purchase equipment and hire technical staff as well as construct a second cleanroom in the basement of the Gordon McKay Laboratory. The management of the shared facilities at Harvard from CIMS, MRSEC and NSEC were integrated in 2002; the management boards of these Centers work closely together. Importantly, instrumentation for new CIMS facilities are

open to all students, research associates, staff and faculty of the NSEC (regardless of institution), and to all NSEC collaborators. This integration made CIMS the main source for centralized user facilities in the Oxford Street science campus. In September 2004, Marcus became the Scientific Director of CIMS. In April 2005, CIMS was renamed to

the Center for Nanoscale Systems and they launched their new website (www.cns.fas.harvard.edu). In January 2006, Eric Martin joined CNS from Avici Systems (North Billerica, MA) as the Technical Director (Fig. 13.4).

CNS has sixteen full-time technical staff members and the available instrumentation is organized in three thematic areas: Imaging and Analysis; Nanofabrication (including cleanroom operation); and Materials Synthesis. The complete list of instrumentation is given at: (www.cns.fas.harvard.edu/facilities/).

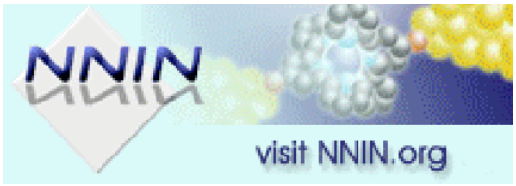
Figure 13.4. Eric Martin, CNS Technical Director, describing the new clean room facilities in LISE to a visiting Japanese delegation.

The most recent instrumentation includes a 200KV Zeiss Libra Monochromated TEM/STEM with in-column energy filter to do high resolution TEM and STEM, energy dispersive X-ray analysis (EDS) and electron energy-loss spectroscopy (EELS). The resolution for this instrument is 1.4 Å with an energy resolution of 0.4 eV for energy filter. Two new field emission scanning electron microscopes have also been installed: a Zeiss Ultra, with ultimate imaging resolution of 1 nm and a Zeiss Supra for imaging and analytical work equipped with electron beam diffraction analysis (EBSD) and EDS. CNS also has a new Elionix STS-7000 E-beam system for nanometer electron-beam lithography. A new multi-beam FIB system, a Zeiss NVision 40, has just arrived that will be used for microfabrication, patterning and sample preparation.

CNS makes a direct, cost-sharing contribution to the NSEC through annual equipment acquisitions. The support and operation of the shared experimental facilities are the responsibility of CNS, with the only recharge to CNS from the NSEC in the form of user fees. The CNS annual budget for the technical staff and operating costs of the shared facilities ($3 M/yr.) represents substantial leveraging of the NSF/NSEC support.

National Nanotechnology Infrastructure Network (NNIN)

UC Santa Barbara and Harvard University are two of the thirteen members of the National Nanotechnology Infrastructure Network (NNIN) began in March 2004. CNS is also responsible for managing the Harvard portion of the NNIN activity (www.nnin.org) that further reaches out to a national user base. The areas of focus at Harvard are soft lithography and the assembly of nanoparticle and molecular electronics; theoretical simulations of electron states and transport in nanoscale systems. These areas have significant overlap with research in the NSEC.



Michael Stopa leads the coordination of the computational initiative in NNIN (Fig. 13.5). Stopa was previously at NTT in Japan and gave several seminars as part of the international exchange programs of the NSEC. Like the NNIN experimental program, NNIN/C is a multi-university initiative, the object of which is to establish a national computing resource that provides hardware resources and simulation tools dedicated to nanoscience research for the academic and industrial research communities. The software tools include commercial software packages for design and analysis, of nanometer scale devices as well as some of the latest academic advances in nanoscale modeling and simulation software. A workshop Synergy Between Experiment and Computation in Nanoscale Science was recently held (Fig. 13.5) that attracted over 100 participants, from other NNIN computational sites, across the nation, and from 12 countries. NSEC speakers at the workshop included Heller, Kaxiras, Marcus, and Whitesides.

Figure 13.5. Michael Stopa talks with participants at a NISE-net forum meeting following his presentation (*left*); NNIN/C workshop on Synergy between Experiment and Computation (*right*).

Fettah Kosar (Fig. 13.6) oversees the operation of the Soft Lithography Foundry (SLF) which supports academic and industrial researchers and trains users on master

fabrication and soft lithography. Fettah completed his Ph.D. in Bioengineering and Nanotechnology from the University of Washington in 2005. Before joining CNS, Kosar was a senior fellow in Paul Yager's group at UW, working on the design and development of a microfluidic point-of-care system for the rapid and on-the-field diagnosis of life-threatening infectious diseases in third-world countries. CNS recently organized a Soft Lithography Technical Forum, which was held on Harvard University with George Whitesides as the keynote speaker (Fig. 13.6). The main goal of the Forum

Figure 13.6. Fettah Kosar (*left)*; George Whitesides (*right*) giving the keynote presentation at the Soft Lithography Technical Forum.

was to disseminate and share technical knowledge and practical information on soft lithography across NNIN sites, as well as to educate and train NNIN personnel on some basic soft lithography techniques. Subject matter included overviews from participating sites, expert presentations, hands-on training sessions, laboratory demos, and tours of functional facilities.

User Statistics

The shared facilities are heavily subscribed with more than 650 users from March 2007 through February 2008. Users came from many different institutions and varied technical fields. Below (Fig. 13.7) is statistical information of the shared facility users. Note that the Other category in the Institution Type chart includes small and large corporations, state and federal agencies, and international institutions. Also, most projects cut across many technical fields. In fact, it is part of the mission of CNS and NNIN to promote such interdisciplinary research. However, for the sake of tracking trends, users must select only one technical field when applying to the CNS/NNIN User Program.

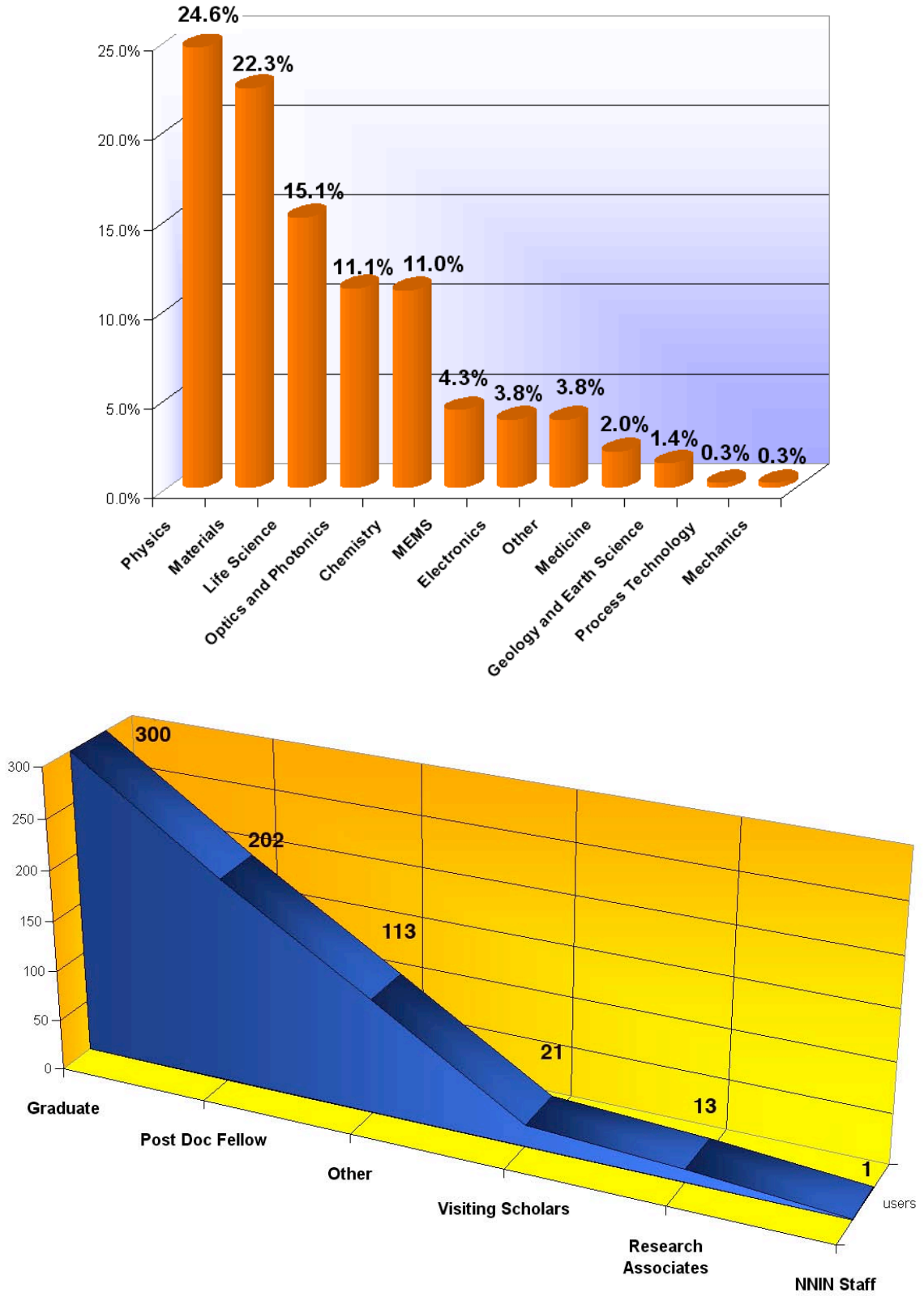


Figure 13.7. Shared Facilities user statistics from March 2007 to February 2008.

Student Training and Safety

Equally important to the acquisition of state-of-the-art instrumentation in the pursuit of our research program, is the availability of talented technical staff that provides training through regularly scheduled courses and hands-on laboratory instruction. The technical staff ensures that environmental health and safety procedures are followed and guidance is provided until researchers are certified as self-users. The staff also helps researchers develop new fabrication processes and measurements techniques, and upgrade equipment in response to changing research needs.

These cutting-edge instruments also are used in many of the Research Experience for Undergraduate (REU) and Teacher (RET) projects and, in many cases, are resources that are not available to many participants in these summer research programs back at their

Figure 13.8. (*Left*) Dr. Steve Cronin and Sasha Stolyarov (REU, Univ. Texas, Dallas) working in one of the cleanrooms; (*right*) Joseph Cox (REU, Eastern Nazarene College) and Visiting Professor John Free, during the summer research experience program.

home institutions (Fig. 13.8). This is an important illustration how the NSEC brings together talented researchers, who serve as mentors for undergraduates and teachers, technical staff with expertise, and essential (and often sophisticated) experimental facilities. Sasha Stolyarov (above) returned to Harvard after finishing his undergraduate degree at the Univ. of Texas at Dallas and entered Harvard as a graduate student in the Department of Physics. Sasha was awarded an NSF Graduate Fellowship.

Other Facilities

Center participants have access to other imaging, clean room, and synthesis facilities at MIT and UC Santa Barbara. With the installation of three new systems (Fig. 13.9), there are now a total of eight different MBE machines available for sample growth at UC Santa Barbara (www.materials.ucsb.edu/~mbe/lablayout.html). NSEC work has also benefited by the addition of an atomic hydrogen source for enhanced cleaning of the semiconductor surfaces and recently added electron beam evaportation sources are now operational that offer increased capabilities for metallization steps. The NSEC has supported exchanges through the travel program by students who are expert in materials

Figure 13.9. (*Left*) The new Engineering Sciences Laboratory which is home to the Nanofabrication Facilities (*right*) at UC Santa Barbara.

growth (UC Santa Barbara) to meet with students working in transport measurement (Cambridge). It is been very valuable in moving research forward for these different groups to gain an understanding of each others' approaches and capabilities. The National Laboratories have excellent capabilities that also help NSEC researchers, particularly those in micro-electromechanical structure (MEMS) fabrication facilities at Sandia (www.cint.lanl.gov). Westervelt serves on the Advisory Board of CINT.

Center participants also benefit strongly from international collaborations with Delft University of Technology in The Netherlands, and the University of Tokyo, the Institute for Industrial Research and NTT in Japan. These institutions are world leaders in mesoscopic science and engineering. Leo Kouwenhoven has created a visiting program with Delft to exchange students and share facilities for collaborative research. Hiroyuki Sakaki and Seigo Tarucha are also coordinating visits with the University of Tokyo, the Institute for Industrial Research, and NTT for the design and fabrication, and testing of nanoscale structures (see also NSEC International Workshops in *12. Outreach and Knowledge Transfer*, above). Our international collaborators have contributed to the travel support for student exchanges and to support joint workshops.

15. NSEC PUBLICATIONS and PATENTS

Note: [a] signifies research principally supported by the NSEC
[b] signifies research partially supported by the NSEC
[c] signifies research where NSEC Facilities were utilized
[d] signifies Patents

1. [a]Abanin, D.A., A.V. Shytov, L.S. Levitov, and **B.I. Halperin**, "Nonlocal charge transport mediated by spin diffusion in the Spin-Hall effect regime," arXiv:0708.0455 (2007).

2. [c]Abkarian, M., A. Bala Subramaniam, S.-H. Kim, R. Larsen, S-M. Yang, and **H.A. Stone**, "Dissolution arrest and stability of armored bubbles through interfacial jamming," *Phys. Rev. Lett.* **99**, 188301 (2007).

3. [b,c]Adams, W.J., P.-L. Kuo, M.-A. Bray, S.P. Sheehy, and **K.K. Parker**, "Modeling nuclear deformation during cardiac contraction," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

4. [a,b]Aidala, K.E., R.E. Parrott, T. Kramer, **E.J. Heller**, **R.M. Westervelt**, M.P. Hanson, and **A.C. Gossard**, "Imaging magnetic focusing of coherent electron waves," *Nature Phys.* **3** (7), 464–468 (2007).

5. [b]**Aizenberg, J.**, "Biomimetic crystallization," Invited talk at the Gordon Research Conference on *Thin Films and Crystal Growth Mechanisms* (June 2007).

6. [c]Akimov, A.V., A. Mukherjee, C.L. Yu, D.E. Chang, A.S. Zibrov, P.R. Hemmer, **H. Park**, and M.D. Lukin, "Generation of single optical plasmons in metallic nanowires coupled to quantum dots," *Nature* **450**, 402–405 (2007).

7. [c]Akopian, N., N.H. Lindner, E. Poem, Y. Berlatzky, J. Avron, D. Gershoni, B.D. Gerardot, and **P.M. Petroff**, "Correlated and entangled pairs of single photons from semiconductor quantum dots," *J. Appl. Phys.* **101** (8), 81712/1–4 (2007).

8. [b]**Alpert, C.L.**, "Addressing *Broader Impacts* through Research Center - Science Museum Partnerships," *Proc. Mater. Res. Soc.,* Fall Meeting, Boston, Symposium W (2007).

9. [b]**Alpert, C.L.**, "Public Engagement with Nanoscale Science and Engineering," in *Nanotechnology: Societal Implications II*, eds. M. Roco, W. Bainbridge, National Science Foundation (Springer, 2007).

10. [b]Andress, W., K. Woo, and **D. Ham**, "Surpassing tradeoffs by separation: Examples in frequency generation circuits," (Invited paper), *IEEE Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems* (IEEE SiRF), pp. 130–133 (January, 2008).

11. [c]Audet, R., M.A. Belkin, J.A. Fan, B.G. Lee, K. Lin, **F. Capasso**, E.E. Narimanov, D. Bour, S. Corzine, J. Zhu, and G. Hofler, "Single-mode laser action in quantum cascade lasers with spiral-shaped chaotic resonators," *Appl. Phys. Lett.* **91**, 131106 (2007).

12. [a]Bao, J., M. Tabbal, T. Kim, S. Charnvanichborikarn, J.S. Williams, M.J. Aziz, and **F. Capasso**, "Point defect engineered Si sub-bandgap light-emitting diode," *Opt. Exp.* **15**, 6727 (2007).

13. [a]Bao, J., N. Yu, **F. Capasso**, T. Mates, M. Troccoli, and A. Belyanin, "Controlled modification of erbium lifetime in silicon dioxide with metallic overlayers," *Appl. Phys. Lett.* **91**, 1 (2007).

14. [c]Baumgartner, A., T. Ihn, K. Ensslin, K. Maranowski, and **A.C. Gossard**, "Quantum Hall effect transition in scanning gate experiments," *Phys. Rev. B* **76** (8), 085316 (2007).

15. [c]Belkin, M.A., **F. Capasso**, A. Belyanin, D.L. Sivco, A.Y. Cho, D.C. Oakley, C.J. Vineis, and G.W. Turner, "Terahertz quantum-cascade-laser source based on intracavity difference-frequency generation," *Nature Photonics* **1**, 288 (2007).

16. [c]Belkin, M.A., M. Lončar, B.G. Lee, C. Pflugl, R. Audet, L. Diehl, **F. Capasso**, D. Bour, S. Corzine and G. Hofler, "Intra-cavity absorption spectroscopy with narrow-ridge microfluidic quantum cascade lasers," *Opt. Exp.* **15**, 11262 (2007).

17. [c]Bian, Z, M. Zebarjadi, R. Singh, Y. Ezzahri, A. Shakouri, G. Zeng, J.H. Bahk, J.E. Bowers, J.M.O. Zide, and **A.C. Gossard**, "Cross-plane Seebeck coefficient and Lorenz number in superlattices," *Phys. Rev. B* **76** (20), 205311 (2007).

18. [a,c]Biener, M.M., J. Biener, and **C.M. Friend**, "Sulfur-induced mobilization of Au surface atoms on Au(111) studied by real-time STM," *Surf. Sci.* **601** (7), 1659–1667 (2007).

19. [a,c]Bleszynski, A.C., F.A. Zwanenburg, **R.M. Westervelt**, A.L. Roest, E.P.A.M. Bakkers, and L.P. Kouwenhoven, "Scanned probe imaging of quantum dots in InAs nanowires," *Nano Lett.* **7**, 2559 (2007).

20. [b,c]Bray, M.-A., N.A. Geisse, and **K.K. Parker**, "Multidimensional detection and analysis of Ca^{2+} sparks in cardiac myocytes," *Biophys J.* **92** (12), 4433–4443 (2007).

21. [b,c]Bray, M.-A., N.A. Geisse, S.P. Sheehy, and **K.K. Parker**, "Nuclear morphology and deformation in micropatterned cardiac myocytes," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

22. [c]Brown, E.R., A.C. Young, J. Zimmerman, H. Kazemi, and **A.C. Gossard**, "Advances in Schottky rectifier performance," *IEEE Microwave Magazine* **8** (3), 54–59 (2007).

23. [c]**Capasso, F.**, N. Yu, E. Cubukcu, **K.B. Crozier**, L. Diehl, B.G. Lee, M.A. Belkin, P. Berhoozi, and **M. Lončar**, "Mid-infrared active optical antennas and optofluidic lasers," Session 6479–34, *Photonics West* (San Jose, CA, January 2007).

24. [c]Chen, H.T., W.J. Padilla, J.M.O. Zide, S.R. Bank, **A.C. Gossard**, A.J. Taylor, and R.D. Averitt, "Ultrafast optical switching of terahertz metamaterials fabricated on ErAs/GaAs nano-island superlattices," *Opt. Lett.* **32** (12), 1620–1622 (2007).

25. [c]Courbin, L., E. Denieul, E. Dressaire, M. Roper, A. Ajdari, and **H.A. Stone**, "Imbibition by polygonal spreading on patterned surfaces," *Nature Mater.* **6**, 661–664 (2007) (cover article).

26. [c]Crook, A.M., E. Lind, Z. Griffith, M.J.W. Rodwell, J.D. Zimmerman, **A.C. Gossard**, and S.R. Bank, "Low resistance, nonalloyed ohmic contacts to InGaAs," *Appl. Phys. Lett.* **91** (19), 192114 (2007).

27. [c]**Crozier, K.B.** and E. Togan, "Experimental measurement of the dispersion relations of metal nanoparticle chains," Session QThB4, Conf. *Lasers and Electro-Optics (CLEO)* (Baltimore, MD, 2007).

28. [c]**Crozier, K.B.,** "Plasmonic laser antenna," (Invited Paper), Session 6485-33, *Photonics West* (San Jose, CA, January, 2007).

29. [b,c]**Crozier, K.B.**, E. Togan, E. Simsek, and T. Yang, "Experimental measurement of the dispersion relations of the surface plasmon modes of gold nanoparticle chain arrays," *Opt. Exp.* **15**, 17482 (2007).

30. [c]Dabiri, B.E., E.H. Weiss, A.W. Feinberg, and **K.K. Parker**, "An *in-vitro* model of cellular injury in traumatic brain injury," *Neurotrauma Soc. Nat. Meeting* (Kansas City, MO, July-August, 2007).

31. [c]Dabiri, B.E., E.H. Weiss, A.W. Feinberg, and **K.K. Parker**, "An *in-vitro* model of integrin mediated neural injury," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

32. [c]Desplantez, T., N.A. Geisse, L. Krapf, A. Werdich, **K.K. Parker**, and A.G. Kleber, "Electrical cell-to-cell coupling in patterned pairs of murine and rat ventricular myocytes," *Heart Rhythm Soc. Scientific Sessions* (Denver, CO, May, 2007).

33. [a]DiCarlo, L., J.R. Williams, Y. Zhang, D.T. McClure, and **C.M. Marcus**, "Shot noise in graphene," arXiv:0711.3206 (2007).

34. [b]Engel, H.-A., E.I. Rashba, and **B.I. Halperin**, "Out-of-plane spin polarization from in-plane electric and magnetic fields," *Phys. Rev. Lett.* **98**, 036602 (2007).

35. [b]Engel, H.-A., E.I. Rashba, and **B.I. Halperin**, "Theory of spin Hall effects in semiconductors," in *Handbook of Magnetism and Advanced Magnetic Materials,* H. Kronmüller and S. Parkin, eds. (John Wiley & Sons, Chichester, UK, 2007) vol. 5, pp 2858–2877. Cond-mat/0603306.

36. [a,c]Falk, A., M. Deshmukh, A.L. Prieto, J.J. Urban, A. Jones, and **H. Park**, "Magnetic switching of phase-slip dissipation in NbSe2 nanobelts," *Phys. Rev. B* **75**, 020501(R) (2007).

37. [c]Fan, J.A., M.A. Belkin, M. Troccoli, S. Corzine, D. Bour, G. Hofler, and **F. Capasso**, "Double-metal waveguide λμm quantum cascade lasers grown by metal organic vapour phase epitaxy," *Electronics Lett.* **43**, 20079450 (2007).

38. [c]Faraon, A., D. Englund, I. Fushman, J. Vučković, N. Stoltz, and **P.M. Petroff**, "Local quantum dot tuning on photonic crystal chips," *Appl. Phys. Lett.* **90** (21), 213,110/1–3 (2007).

39. [c]Feinberg, A.W., S.P. Sheehy, and **K.K. Parker,** "*In-vitro* contractility assay correlates sarcomere alignment with systolic stress in 2-D myocardium," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

40. [c]Feinberg, A.W., A. Feigel, S.S. Shevkoplyas, S.P. Sheehy, **G.M. Whitesides**, and **K.K. Parker**, "Muscular thin films for building actuators and powering devices," *Science* **317** (5843), 1366–1370 (2007).

41. [c]Feinberg, A.W., S.P. Sheehy, and **K.K. Parker**, "Microstructured multi-component protein scaffolds for cardiac tissue engineering," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

42. [b]Finkler, I.G., H.-A. Engel, E.I. Rashba, and **B.I. Halperin**, "Spin generation away from boundaries by nonlinear transport," *Phys. Rev. B* **75**, 241202 (2007).

43. [a]Foletti, S., J. Martin, M. Dolev, D. Mahalu, V. Umansky, and **A. Yacoby**, "Dynamic nuclear polarization using a single pair of electrons," arXiv:0801.3613v1 (2008).

44. [c]Fuerstman, M. J., P. Garstecki, and **G.M. Whitesides**, "Coding/decoding and reversibility of droplet trains in microfluidic networks," *Science* **315** (5813), 828–832 (2007).

45. [c]Fuerstman, M.J., A. Lai, M.E. Thurlow, S.S. Shevkoplyas, **H.A. Stone**, and **G.M. Whitesides**, "The pressure drop along rectangular microchannels containing bubbles," *Lab on a Chip* **7**, 1479–1489 (2007).

46. [c]Fushman, I., E. Waks, D. Englund, N. Stoltz, **P.M. Petroff**, and J. Vučković, "Ultrafast nonlinear optical tuning of photonic crystal cavities," *Appl. Phys. Lett.* **90** (9), 91118/1–3 (2007).

47. [c]Fyta, M., S. Melchionna, **E. Kaxiras**, and S. Succi, "Multiscale modeling of biopolymer translocation through a nanopore," *Lecture Notes in Computer Science* **4487**, 786; Best Paper in a Workshop award, *Internat. Conf. Computat. Sci.* (ICCS, 2007).

48. [b]Gao, W., L. Zhou, D.S. Pinnaduwage, and **C.M. Friend**, "Interaction of chlorine with Au-O surface complexes," *J. Phys. Chem. C* **111** (26), 9005–9007 (2007).

49. [c]Geisse, N.A., S.P. Sheehy, and **K.K. Parker**, "Cardiace myocyte size and cytoskeletal architecture are independently regulated by cell shape," *Mater. Res. Soc (MRS) Fall Meeting* (Boston, MA, November, 2007).

50. [b,c]Geisse, N.A., M.-A. Bray, B. Dabiri, S.P. Sheehy, and **K.K. Parker**, "Distribution of calcium sparks in micropatterned cardiac myocytes," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

51. [c]Geisse, N.A., S.P. Sheehy, and **K.K. Parker**, "Myofibrillar and cellular structure of cardiac myocytes: A combined confocal and atomic force microscopy study," *Euro AFM Forum* (University of Műnster, Germany, September, 2007).

52. [c]Geisse, N.A., S.P. Sheehy, and **K.K. Parker**, "Myofibrillar and cellular structure of micropatterned cardiac myocytes: A combined confocal and atomic force

microscopy study," *Surf. Sci. Biol. Important Interfaces Group Conf.,* Manchester, UK (September, 2007).

53. [c]Geisse, N.A., S.P. Sheehy, and **K.K. Parker**, "Myofibrillar and cellular structure of micropatterned cardiac myocytes: A combined confocal and atomic force microscopy study," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

54. [c]Gerardot, B.D., S. Seidl, P.A. Dalgarno, R.J. Warburton, D. Granados, J.M. Garcia, K. Kowalik, O. Krebs, K. Karrai, A. Badolato, and **P.M. Petroff**, "Manipulating exciton fine structure in quantum dots with a lateral electric field," *Appl. Phys. Lett*. **90** (4), 41101/1–3 (2007).

55. [c]Gerardot, B.D., S. Seidl, P.A. Dalgarno, R.J. Warburton, M. Kroner, K. Karrai, A. Badolato, and **P.M. Petroff**, "Contrast in transmission spectroscopy of a single quantum dot," *Appl. Phys. Lett.* **90** (22), 221106/1-3 (2007).

56. [c]Gildemeister, A.E., T. Ihn, R. Schleser, K. Ensslin, D.C. Driscoll, and **A.C. Gossard**, "Imaging a coupled quantum dot-quantum point contact system," *J. Appl. Phys.* **102** (8), 083703 (2007).

57. [c]Gildemeister, A.E., T. Ihn, M. Sigrist, K. Ensslin, D.C. Driscoll, and **A.C. Gossard**, "*In situ* treatment of a scanning gate microscopy tip," *Appl. Phys. Lett*. **90** (21), 213113 (2007).

58. [c]Gildemeister, A.E., T. Ihn, M. Sigrist, K. Ensslin, D.C. Driscoll, and **A.C. Gossard**, "Measurement of the tip-induced potential in scanning gate experiments," *Phys. Rev. B* **75** (19), 195338 (2007).

59. [b,c]Gu, Q., A. Falk, J. Wu, L. Ouyang, and **H. Park**, "Current-driven phase oscillation and domain-wall propagation in $W_xV_{1-x}O^2$ nanobeams," *Nano Lett.* **7**, 363–366 (2007).

60. [c]Gustavsson, S., R. Leturcq, T. Ihn, K. Ensslin, D.C. Driscoll, and **A.C. Gossard**, "Noise measurements in quantum dots using charge detection techniques," *Physica E-Low-Dim. Sys. Nanostruct.* **40** (1), 103–110 (2007).

61. [c]Gustavsson, S., M. Studer, R. Leturcq, T. Ihn, K. Ensslin, D.C. Driscoll, and **A.C. Gossard**, "Frequency-selective single-photon detection using a double quantum dot," *Phys. Rev. Lett.* **99** (20), 206804 (2007).

62. [a,c]**Ham, D.** and **R.M. Westervelt**, "The silicon that moves and feels small living things," (Invited paper), *IEEE Sol.-State Circ. Soc. Newsletter,* Fall issue **12** (4), 4–9 (October, 2007).

63. [c]Han, T.Y.-J and **J. Aizenberg**, "Calcium carbonate storage in amorphous form and its template-induced crystallization," *Chem. Mater*. Published on the web December 11, 2007.

64. [c]Hashimoto, M., P. Garstecki, and **G.M. Whitesides**, "Synthesis of composite emulsions and complex foams with the use of microfluidic flow-focusing devices," *Small* **3** (10), 1792–1802 (2007).

65. [c]Hanson, M.P., S.R. Bank, J.M.O. Zide, J.D. Zimmerman, and **A.C. Gossard**, "Controlling electronic properties of epitaxial nanocomposites of dissimilar materials," *J. Crystal Growth* **301**, 4–9 (2007).

66. [a]Hatton, B. and **J. Aizenberg**, "Localized deposition on a superhydrophobic nanowire array," Oral presentation at the *MRS Fall Meeting* (November 2007).

67. [b]He, J., H.J. Krenner, C. Pryor, J.P. Zhang, Y. Wu, D.G. Allen, C.M. Morris, M.S. Sherwin, and **P.M. Petroff**,, "Growth, structural, and optical properties of self-assembled (InGa)As quantum posts on GaAs," *Nano Lett.* **7**, 802–806 (2007).

68. [b]**Heller, E.J.** and B.R. Landry, "Statistical properties of chaotic wave functions in two and more dimensions," *Eur. Phys. J.: Spec. Top.* **145**, 231–244 (2007).

69. [b]**Heller, E.J.** and B.R. Landry, "Statistical properties of many particle eigenfunctions," *J. Phys. A: Math. Theor.* **40** (31), 9259–9274 (2007).

70. [c]High, A.A., A.T. Hammack, L.V. Butov, M.P. Hanson, and **A.C. Gossard**, "Exciton optoelectronic transistor," *Opt. Lett.* **32** (17), 2466–2468 (2007).

71. [c]Holleitner, A.W., V. Sih, R.C. Myers, **A.C. Gossard**, and D.D. Awschalom, "Dimensionally constrained D'yakonov-Perel' spin relaxation in n-InGaAs channels: Transition from 2-D to 1-D," *New J. Phys.* **9**, 342 (2007).

72. [b]Hu, Y., H.O.H. Churchill, D.J. Reilly, J. Xiang, **C.M. Lieber**, and **C.M. Marcus**, "Double quantum dot with integrated charge sensor based on Ge/Si heterostructure nanowires," *Nature Nanotech.* **2**, 622 (2007).

73. [c]Hulme, S.E., S.S. Shevkoplyas, J. Apfeld, W. Fontana, and **G.M. Whitesides**, "A microfabricated array of clamps for immobilizing and imaging *C. elegans,*" *Lab on a Chip* **7**, 1515–1523 (2007).

74. [b]Insin, N., J.B. Tracy, H. Lee, J.P. Zimmer, **R.M. Westervelt**, and **M.G. Bawendi**, "Incorporation of iron oxide nanoparticles and quantum dots into silica microspheres," *ACS Nano* **2**, 197–202 (2007).

75. [c]Jackson, A.W. and **A.C. Gossard**, "Thermal imaging of wafer temperature in MBE using a digital camera," *J. Crystal Growth* **301**, 105–108 (2007).

76. [c]Kanicki, J., P.B. Shea, L.R. Pattison, M. Kawano, C. Chen, J. Chen, **P.M. Petroff**, D.C. Martin, H. Yamada, and N. Ono, "Solution-processed polycrystalline copper tetrabenzoporphyrin thin-film transistors," *Synth. Met.* **157** (4–5), 190–197 (2007).

77. [c]Klenov, D.O., J.M.O. Zide, J.M. LeBeau, **A.C. Gossard**, and S. Stemmer, "Ordering of ErAs nanoparticles embedded in epitaxial InGaAs layers," *Appl. Phys. Lett.* **90** (12), 121917 (2007).

78. [b]Krenner, H.J., C. Pryor, J. He, J.P. Zhang, Y. Wu, C.M. Morris, M.S. Sherwin, and **P.M. Petroff**, "Growth and optical properties of self-assembled InGaAs quantum posts," *Physica E,* doi:10.1016/j.physe.2007.09.165 (2007).

79. [a]Krich, J.J. and **B.I. Halperin**, "Cubic Dresselhaus spin-orbit coupling in 2-D electron quantum dots," *Phys. Rev. Lett.* **98**, 226802 (2007).

80. [b,c]Kuo, P.-L., C. Guo, N.A. Geisse, M.-A. Bray, S.P. Sheehy, and **K.K. Parker**, "Myofibrillogenesis and cytoskeletal self-assembly in cardiac myocytes," *Biomed. Engin. Soc. (BMES) Ann. Meeting* (Los Angeles, CA, September, 2007).

81. [a,b]Laird, E.A., C. Barthel, E.I. Rashba, **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "Hyperfine-mediated gate-driven electron spin resonance," *Phys. Rev. Lett.* **99** (24), 246601 (2007).

82. [b]LeDuc, P.R., M.S. Wong, P.M. Ferreira, R.E. Groff, K. Haslinger, M.P. Koonce, W.Y. Lee, J.C. Love, J.A. McCammon, N.A. Monteiro-Riviere, V.M. Rotello, G.W. Rubloff, **R.M. Westervelt**, and M. Yoda, "A nanotechnology approach towards an *in vivo* biologically inspired factory," *Nature Nanotech.* **2**, 3–7 (2007).

83. [a,c]Lee, H., **D. Ham**, and **R.M. Westervelt,** "CMOS/Microfluidic Hybrid Systems," in *CMOS Biotechnology*, editors H. Lee, D. Ham, and R.M. Westervelt, pp. 77–100 (Springer, 2007).

84. [a,c]Lee, H., Y. Liu, **D. Ham**, and **R.M. Westervelt**, "Integrated cell manipulation system – CMOS/microfluidic hybrid," *Lab on a Chip* **7** (3), 331–337 (2007).

85. [c]Li, X., D. Ricketts, and **D. Ham**, "Solitons in electrical networks," *Yearbook of Science and Technology* (McGraw-Hill, 2007).

86. [c]Lee, B.G, M.A. Belkin, R. Audet, J. MacArthur, L. Diehl, C. Pfluegl, **F. Capasso**, D.C. Oakley, D. Chapman, A. Napoleone, D. Bour, S. Corzine, G. Hofler, and J. Faist, "Widely tunable single-mode quantum cascade laser source for mid-infrared spectroscopy," *Phys. Lett.* **91**, 231101 (2007).

87. [a]Liu, Y., W. Rhee, D. Friedman, and **D. Ham**, "All-digital dynamic self-detection and self-compensation of static phase offsets in charge-pump PLLs," *IEEE Internat. Sol.-State Circ. Conf.* (*ISSCC*), *Digest of Technical Papers*, pp. 176–177 (February, 2007).

88. [a,c]Liu, Y., H. Lee, **R.M. Westervelt**, and **D. Ham**, "CMOS-based Magnetic Cell Manipulation System," in *CMOS Biotechnology*, editors H. Lee, D. Ham, and R.M. Westervelt, pp. 103–142 (Springer, 2007).

89. [a,c]Liu, Y., N. Sun, H. Lee, R. Weissleder, and **D. Ham**, "CMOS mini nuclear magnetic resonance (NMR) system and its application for biomolecular sensing," *IEEE Internat. Solid-State Circ. Conf. (ISSCC), Digest of Technical Papers*, pp. 140–141 (February, 2008).

90. [c]Lončar, M., B.G. Lee, L. Diehl, M.A. Belkin, **F. Capasso**, M. Giovannini, J. Faist, and E. Gini, "Design and fabrication of photonic crystal quantum cascade lasers for optofluidics," *Opt. Exp.* **15,** 4499 (2007).

91. [a,b]MacLean, K., S. Amasha, I.P. Radu, D.M. Zumbühl, **M.A. Kastner**, M.P. Hanson, and **A.C. Gossard**, "Energy-dependent tunneling in a quantum dot," *Phys. Rev. Lett.* **98**, 036802 (2007).

92. [a]McClure, D.T., L. DiCarlo, Y. Zhang, H.A. Engel, **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "Tunable noise cross correlations in a double quantum dot," *Phys. Rev. Lett.* **98** (5), 056801 (2007).

93. [a]Mani, R. and **S. Ramanathan**, "Observation of uniform temperature dependence in the electrical resistance across the structural phase transition in thin film vanadium oxide," *Appl. Phys. Lett.* **91**, 062104 (2007).

94. [a]Martin, J., N. Akerman, G. Ulbricht, T. Lohmann, J. H. Smet, K. von Klitzing, and **A. Yacoby**, "Observation of electron-hole puddles in graphene using a scanning single electron transistor," *Nature Phys.* **4**, 144 –48 (2008).

95. [c]Martinez, A.W., S.T. Phillips, M.J. Butte, and **G.M. Whitesides**, "Patterned paper as a platform for inexpensive, low volume, portable bioassays," *Ang. Chemie Int. Ed.* **46**, 1318–1320 (2007).

96. [c]McCarty, L.S., A. Winkleman, and **G.M. Whitesides**, "Ionic electrets: Electrostatic charging of surfaces by transferring mobile ions upon contact," *J. Am. Chem. Soc.* **129** (13), 4075–4087 (2007).

97. [a]McClure, D.T., L. DiCarlo, Y. Zhang, H.-A. Engel, **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "Tunable noise cross correlations in a double quantum dot," *Phys. Rev. Lett.* **98**, 056801 (2007).

98. [b,c]Mendonca, C., T. Baldacchini, P. Tayalia, and **E. Mazur**, "Reversible birefringence in microstructures fabricated by two-photon absorption polymerization," *J. Appl. Phys.* **103**, 013109/1–4 (2007).

99. [c]Mendonca, C.R., S. Orlando, G. Cosendey, M.T. Winkler, and **E. Mazur**, "Femtosecond laser micromachining in the conjugated polymer MEH-PPV," *Appl. Surf. Sci.* **254**, 1135–1139 (2007).

100. [a,b]Miller, J.B., I.P. Radu, D.M. Zumbühl, E.M. Levenson-Falk, **M.A. Kastner**, **C.M. Marcus**, L.N. Pfeiffer, and K.W. West, "Fractional quantum Hall effect in a quantum point contact at filling fraction 5/2," *Nature Phys.* **3**, 561 (2007).

101. [b]Min, B.K. and **C.M. Friend**, "Heterogeneous gold-based catalysis for green chemistry: Low-temperature CO oxidation and propene oxidation," *Chem. Rev.* **107** (6), 2709–2724 (2007).

102. [c]Moon, M.-W., S. Chung, K.-R. Lee, K.H. Oh, **H.A. Stone**, and J.W. Hutchinson, "Directed assembly of fluidic networks by buckle delamination of films on patterned substrates," *Intl. J. Mater. Res.* **98**, 1203–1208 (2007).

103. [b]Mourokh, L., A. Smirnov, J. Bird and M. Stopa, "Fano resonances in the system of coupled quantum point contacts," *J. Computer-Aided Mater. Design* 14, 97 (2007).

104. [b]Munday, J.N. and **F. Capasso**, "Precision measurement of the Casimir-Lifshitz force in a fluid," *Phys. Rev. A Rapid Commun.* **75**, 60102 (2007).

105. [b]Nair, G. and **M.G. Bawendi**, "Carrier multiplication yields of CdSe and CdTe nanocrystals by transient photoluminescence spectroscopy," *Phys. Rev. B* **76**, 081304 (R) (2007).

106. [c]Nemat-Nasser, S.C., A.V. Amirkhizi, W.J. Padilla, D.N. Basov, S. Nemat-Nasser, D.A. Bruzewicz, and **G.M. Whitesides**, "Terahertz plasmon composites," *Phys. Rev. E* **75**, 036614/1–7 (2007).

107. [b,c]O'Grady, M.L. and **K.K. Parker**, "Conductive polymer films to dynamically control protein-protein interactions," *Mater. Res. Soc. (MRS) Fall Meeting* (Boston, MA, November, 2007).

108. [b,c]O'Grady, M.L. and **K.K. Parker**, "Dynamic control of protein-protein interactions," *Langmuir* **24** (1), 316–322 (2008).

109. [a,c]Ouyang, L., K.N. Maher, C.L. Yu, J. McCarty, and **H. Park**, "Catalyst-assisted solution-liquid-solid synthesis of CdS/CdSe nanorod heterostructures," *J. Am. Chem. Soc.* **129**, 133–138 (2007).

110. [c]Ozcan, A., E. Cubukcu, A. Bilenca, **K.B. Crozier**, B.E. Bouma, **F. Capasso**, and G.J. Tearney, "Differential near-field scanning optical microscopy," Session QTuK3, Conf. *Lasers and Electro-Optics (CLEO),* (Baltimore, MD, 2007).

111. [c]**Parker, K.K.** and D.E. Ingber, "Extracellular matrix, mechanotransduction and structural hierarchies in heart tissue engineering," *Proc. Roy. Soc.* (2007).

112. [c]Passmann, R., M. Kropp, T. Bruhn, B.O. Fimland, F.L. Bloom, **A.C. Gossard**, W. Richter, N. Esser, and P. Vogt, "Optical anisotropy of cyclopentene terminated GaAs(001) surfaces," *Appl. Phys. A Mater. Sci. and Proc.* **87** (3), 469–473 (2007).

113. [b]Payne, C.K., S. Jones, C. Chen, and **X. Zhuang**, "Internalization and trafficking of cell surface proteoglycans and proteoglycan binding ligands," *Traffic* **8**, 389–401 (2007).

114. [c]Petta, J.R., J.M. Taylor, A.C. Johnson, **A. Yacoby**, M.D. Lukin, **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "Dynamic nuclear polarization with single electron spins," arXiv:0709.0920v1 (2007).

115. [b]Pinnaduwage, D.S., L. Zhou, W. Gao, and **C.M. Friend**, "Chlorine promotion of styrene epoxidation on Au(111)," *J. Am. Chem. Soc*. **129** (7), 1872–1873 (2007).

116. [a]Pokroy, B. and **J. Aizenberg**, "Calcite shape modulation through the lattice mismatch between the self-assembled monolayer template and the nucleated crystal face," *Cryst. Eng. Comm*. **9**, 1219–1225 (2007).

117. [a]Pokroy, B. and **J. Aizenberg**, "Calcite shape modulation through the lattice mismatch between the self-assembled monolayer template and the nucleated crystal face," Invited talk at the *MRS Fall Meeting* (November 2007).

118. [c]Polte, T.R., M. Shen, J. Karavitis, M. Montoya, J. Pendse, S. Xia, **E. Mazur**, and D.E. Ingber, "Nanostructured magnetizable materials that switch cells between life and death," *Biomater.* **28**, 2783–2790 (2007).

119. [c]Preu, S., F.H. Renner, S. Malzer, G.H. Dohler, L.J.Wang, M.P. Hanson, **A.C. Gossard**, T.L.J. Wilkinson, and E.R. Brown, "Efficient terahertz emission from ballistic transport enhanced n-i-p-n-i-p superlattice photomixers," *Appl. Phys. Lett.* **90** (21), 212115 (2007).

120. [a]Qian, J. and **B.I. Halperin**, "Hartree-Fock calculations of finite inhomogeneous quantum wire," arXiv:0707.2992 (2007).

121. [a,c]Quek, S.Y., M.M. Biener, J. Biener, J. Bhattacharjee, **C.M. Friend**, V.U. Waghmare, and **E. Kaxiras**, "Structure of incommensurate gold sulfide monolayer on Au(111)," *J. Phys. Chem.* **127** (10), 104704 (2007).

122. [a,c]Reilly, D.J., **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "Fast single-charge sensing with a rf quantum point contact," *Appl. Phys. Lett.* **91** (16), 162101 (2007).

123. [c]Reilly, D.J., J.M. Taylor, E.A. Laird, J.R. Petta, **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "The dynamic nuclear environment in a double quantum dot," arXiv:0712.4033 (2007).

124. [b,c]Ricketts, D., X. Li, N. Sun, K. Woo, and **D. Ham**, "On the self-generation of electrical soliton pulses," *IEEE J. Solid-State Circ.* (*JSSC*) **42** (8), 1657–1668 (August, 2007).

125. [c]Ristenpart, W.D., P.G. Kim, C. Domingues, J. Wan, and **H.A. Stone**, "Influence of substrate conductivity on circulation reversal in evaporating drops," *Phys. Rev. Lett.* **99**, 234502 (2007).

126. [a]Ruzmetov, D., S. Senanayake, and **S. Ramanathan**, "X-ray absorption spectroscopy studies of vanadium oxide thin films across the phase transition boundary," *Phys. Rev. B* **75**, 195102 (2007).

127. [a]Ruzmetov, D., K. Zawilski, **V. Narayanamurti** and **S. Ramanathan**, "Structure-functional property relationships in RF-sputtered vanadium oxide thin films," *J. Appl. Phys.* **102**, 113715 (2007).

128. [c]Schleser, R., S. Kicin, C. Roth, C. Ebneter, R. Leturcq, K. Ensslin, D.C. Driscoll, and **A.C. Gossard**, "Influence of HCl etching on the electronic properties of LAO-defined nanostructures," *Semicond. Sci. Tech.* **22** (4), 337–341 (2007).

129. [c]Shea, P.B., L.R. Pattison, M. Kawano, C. Chen, J. Chen, **P.M. Petroff**, D.C. Martin, H. Yamada, N. Ono, and J. Kanicki, "Solution-processed polycrystalline copper tetrabenzoporphyrin thin-film transistors," *Synth. Metals* **157** (4–5), 190–197 (2007).

130. [b]Shevkoplyas, S.S., A.C. Siegel, **R.M. Westervelt**, M. Prentiss, and **G.M. Whitesides**, "The force acting on a superparamagnetic bead due to an applied magnetic field," *Lab on a Chip* **7**, 1294–1302 (2007).

131. [b,c]Shih, T., R.R. Gattass, C.R. Mendonca, and **E. Mazur**, "Faraday rotation in femtosecond laser micromachined waveguides," *Opt. Exp.* **15**, 5809–5814 (2007).

132. [c]Siegel, A.C., D. Bruzewicz, D.B. Weibel, and **G.M. Whitesides**, "Microsolidics: Fabrication of three-dimensional metallic microstructures in Poly(dimethylsiloxane)," *Adv. Mater.* **19** (5), 727–733 (2007).

133. [a]Smistrup, K. and **H.A. Stone**, "A magnetically actuated ball valve applicable for small-scale fluid flows," *Phys. Fluids* **19**, 063101 (2007).

134. [c]Stern, N.P., R.C. Myers, M. Poggio, **A.C. Gossard**, and D.D. Awschalom, "Confinement engineering of s-d exchange interactions in $Ga_{1-x}Mn_xAs/Al_yGa_{1-y}As$ quantum wells," *Phys. Rev. B* **75** (4), 045329 (2007).

135. [c]Stern, N.P., D.W. Steuerman, S. Mack, **A.C. Gossard**, and D. Awschalom, "Drift and diffusion of spins generated by the spin Hall effect," *Appl. Phys. Lett.* **91** (6), 062109 (2007).

136. [a,c]**Stone, H.A**., "An Introduction to Fluid Mechanics for Microfluidic Flows," in *CMOS Biotechnology*, editors H. Lee, D. Ham, and R.M. Westervelt, pp. 5–30 (Springer, 2007).

137. [b]**Stopa, M.**, "Synergy between experiment and computation in nanoscale science," *J. Computer-Aided Mater. Design* **14**, 1 (2007).

138. [b]Taylor, J.M., J.R. Petta, A.C. Johnson, **A. Yacoby**, **C.M. Marcus**, and M.D. Lukin, "Relaxation, dephasing, and quantum control of electron spins in double quantum dots," *Phys. Rev. B* **76**, 035315 (2007).

139. [a]Tserkovnyak, Y., **B.I. Halperin**, A.A. Kovalev, and A. Brataas, "Boundary spin Hall effect in a Rashba semiconductor," *Phys. Rev. B* **76**, 085319 (2007).

140. [a]Vaishnav, J.Y., J.D. Walls, M. Apratim, and **E.J. Heller**, "Matter-wave scattering and guiding by atomic arrays," *Phys. Rev. A* **76** (1), doi:10.1103/PhysRevA.76.013620 (2007).

141. [a,c]Voss, T., G.T. Svacha, **E. Mazur**, S. Mueller, C. Ronning, D. Konjhodzic, and F. Marlow, "High order waveguide modes in ZnO nanowires," *Nano Lett.* **7**, 3675–3680 (2007).

142. [a]Walls, J.D. and **E.J. Heller**, "Spin-orbit coupling induced interference in quantum corrals," *Nano Lett.* **7** (11), 3377–3382 (2007).

143. [c]Wang, C.Y., L. Diehl, A. Gordon, C. Jirauschek, F.X. Kartner, A. Belyanin, D. Bour, S. Corzine, G. Hofler, M. Troccoli, J. Faist, and **F. Capasso**, "Coherent instabilities in a semiconductor laser with fast gain recovery," *Phys. Rev. A Rapid Commun.* **75**, 1802 (2007).

144. [c]Weibel, D.B., A. Siegel, A. Lee, A.H. George, and **G.M. Whitesides**, "Pumping fluids in microfluidic systems using the elastic deformation of poly(dimethylsiloxane)," *Lab on a Chip* **7**, 1832–1836 (2007).

145. [b]Weiss, E.A., R.C. Chiechi, S.M. Geyer, V.J. Porter, D.C. Bell, **M.G. Bawendi**, and **G.M. Whitesides**, "Size-dependent charge collection in junctions containing single-size and multi-size arrays of colloidal CdSe quantum dots," *J. Am. Chem. Soc* **130**, 74–82 (2007).

146. [b]Weiss, E.A., R.C. Chiechi, G.K. Kaufman, J.K. Kriebel, Z. Li, M. Duati, M.A. Rampi, and **G.M. Whitesides**, "Influence of defects on the electrical characteristics of mercury drop-junctions: Self-assembled monolayers of *n*-alkanethiolate on rough and smooth silver," *J. Am. Chem. Soc.* **129** (14), 4336–4349 (2007).

147. [b]Weiss, E., G.K. Kaufman, J.K. Kriebel, Z. Li, and **G.M. Whitesides**, "Si/$Si0_2$-templated formation of ultraflat metal surfaces on glass, polymer, and solder supports: Their use as substrates for self-assembled monolayers (SAMs)," *Langmuir* **23**, 9686–9694 (2007).

148. [c]Weiss, E., J.K. Kriebel, M.A. Rampi, and **G.M. Whitesides**, "The study of charge transport through organic thin films: Mechanisms, tools and applications," *Phil. Trans. R. Soc. A* **365** (1855), 1509–1537 (2007).

149. [b]Weiss, E.A., V.J. Porter, R.C. Chiechi, S.M. Geyer, D.C. Bell, **M.G. Bawendi**, and **G.M. Whitesides**, "The use of size-selective excitation to study photocurrent through junctions containing single-size and multi-size arrays of colloidal CdSe quantum dots," *J. Am. Chem. Soc.***130**, 83–92 (2007).

150. [a]Williams, J.R., L. DiCarlo, and **C.M. Marcus**, "Quantum Hall effect in a gate-controlled p-n junction of graphene," *Science* **317**, 638 (2007).

151. [c]Winbow, A.G., A.T. Hammack, L.V. Butov, and **A.C. Gossard**, "Photon storage with nanosecond switching in coupled quantum well nanostructures," *Nano Lett.* **7** (5), 1349–1351 (2007).

152. [b]Winkleman, A., R. Perez-Castillejos, K.L. Gudiksen, S.T. Phillips, M. Prentiss, and **G.M. Whitesides**, "Density-based diamagnetic separation: Devices for detecting binding events and for collecting unlabled diamagnetic particles in paramagnetic solutions," *Anal. Chem.* **79** (17), 6542–6550 (2007).

153. [b]Winkleman, A., R. Perez-Castillejos, M. Lahav, M. Narovlyansky, L.N.J. Rodriguez, and **G.M. Whitesides**, "Patterning micron-sized features in a cross-linked poly(acrylic acid) film by a wet etching process," *Soft Matter* **3**(1), 108–116 (2007).

154. [b]Woo, K., Y. Liu, and **D. Ham**, "Fast-lock hybrid PLL combining fractional- & integer-N modes of differing bandwidths," *Proc. IEEE VLSI Symp.,* pp. 260–261 (June, 2007).

155. [b]Woo, K., Y. Liu, E. Nam, and **D. Ham**, "Fast-lock hybrid PLL combining fractional-N and integer-N modes of differing bandwidths," *IEEE J. Sol.-State Circ.* (*JSSC*) **43** (2), 379 –389 (2008).

156. [b]Xu, Q., R.M. Rioux, and **G.M. Whitesides**, "Fabrication of complex metallic nanostructures by nanoskiving," *ACS Nano* **1** (3), 215–227 (2007).

157. [b,c]Xu, Q., J. Bao, R.M. Rioux, R. Perez-Castillejos, **F. Capasso**, and **G.M. Whitesides**, "Fabrication of large-area patterned nanostructures for optical applications by nanoskiving," *Nano Lett.* **7** (9), 2800–2805 (2007).

158. [c]Yang, T. and **K.B. Crozier**, "Dispersion and extinction of the plasmon mode in a gold nanoparticle array at an air/glass interface," in *Lasers and Electro-Optics Society (LEOS),* Annual Meeting, Session WF2*,* October (Lake Buena Vista, FL, 2007).

159. [c]Yang, S., A.V. Mintsev, A.T. Hammack, L.V. Butov, and **A.C. Gossard**, "Repulsive interaction in the macroscopically ordered exciton state in GaAs/$Al_xGa_{1-x}As$ coupled quantum well structures," *Phys. Rev. B* **75** (3), 033311 (2007).

160. [a,b]Yi, W., **V. Narayanamurti**, J.M.O. Zide, S.R. Bank, and **A.C. Gossard**, "Probing energy barriers and quantum confined states of buried semiconductor

heterostructures with ballistic carrier injection: An experimental study," *Phys. Rev. B* **75** (11), 115333 (2007).

161. [c]Young, A.C., J.D. Zimmerman, E.R. Brown, and **A.C. Gossard**, "Low-frequency noise in epitaxially grown Schottky junctions," *J. Appl. Phys.* **101** (8), 084509 (2007).

162. [a,c]Yu, N., E. Cubukcu, L. Diehl, M. Belkin, **K.B. Crozier**, **F. Capasso**, D. Bour, S. Corzine, and G. Hofler, "Plasmonic quantum cascade laser antenna," *Appl. Phys. Lett.* **91**, 173113 (2007).

163. [a,c]Yu, N., E. Cubukcu, L. Diehl, D. Bour, S. Corzine, J. Zhu, G. Hofler, **K.B. Crozier**, and **F. Capasso**, "Bowtie plasmonic quantum cascade laser," *Opt. Exp.* **15**, 13272 (2007).

164. [c]Yu, N., E. Cubukcu, L. Diehl, **K.B. Crozier**, and **F. Capasso**, "Plasmonic quantum cascade laser antenna," Session JMA6, Conf. *Lasers and Electro-Optics (CLEO),* (Baltimore, MD, 2007).

165. [a,c]Yu, N., L. Diehl, E. Cubukcu, C. Pfugl, D. Bour, S. Corzine, J. Zhu, G. Hofler, **K.B. Crozier** and **F. Capasso**, "Near-field imaging of quantum cascade laser transverse modes," *Opt. Exp.* **15**, 13227 (2007).

166. [c]Zeng, G.H., J.M.O. Zide, W. Kim, J.E. Bowers, **A.C. Gossard**, Z.X. Bian, Y. Zhang, A. Shakouri, S.L. Singer, and A. Majumdar, "Cross-plane Seebeck coefficient of ErAs: InGaAs/InGaAlAs superlattices," *J. Appl. Phys.* **101** (3), 034502 (2007).

167. [a,b]Zhang, Y., L. DiCarlo, D.T. McClure, M. Yamamoto, S. Tarucha, **C.M. Marcus**, M.P. Hanson, and **A.C. Gossard**, "Noise correlations in a Coulomb-blockaded quantum dot," *Phys. Rev. Lett.* **99** (3), 036603 (2007).

168. [b]Zhou, Y. and **X. Zhuang**, "Kinetic analysis of sequential multi-step reactions," *J. Phys. Chem. B* **111**, 13600–13610 (2007).

169. [a]Zimmler, M.A., J. Bao, I. Shalish, W. Yi, **V. Narayanamurti**, and **F. Capasso**, "A two-colour heterojunction unipolar nanowire light-emitting diode by tunnel injection," *Nanotech.* **18,** 395201 (2007).

170. [a,b]Zimmler, M.A., J. Bao, I. Shalish, W. Yi, J. Yoon, **V. Narayanamurti**, and **F. Capasso**, "Electroluminescence from single nanowires by tunnel injection: An experimental study," *Nanotech.* **18**, 235205 (2007).

PATENTS

1. **Aizenberg, J.** and B. Hatton (inventors), "Fluidics-induced localized assembly of materials using a superhydrophobic surface structure," Serial No. 60/991,090, filed Nov. 29 (2007).
2. **Crozier, K.B.** (inventor), "System and method for near-field optical tweezers," Serial No. 60/952,498, filed Jul. 27 (2007).
3. **Ham, D.**, N. Sun, and Y. Liu (inventors), "Integrated RF transceiver for NMR systems," Serial No. 60/977,580, filed October 4, 2007. (This provisional patent will be absorbed into a patent of a larger scope, which will be filed together by MGH and Harvard).
4. Lecuyer, S., W.D. Ristenpart, O. Vincent, and **H.A. Stone** (inventors), "Electrohydrodynamic aggregation and flow fractionation of giant vesicles," Patent provisional filing.
5. **Mazur, E.** and E. Diebold (inventors), "Metallized semiconductor substrates for Raman spectroscopy," Serial No. 60/886,244, filed Jan. 23 (2007).
6. **Mazur. E**. and E. Diebold (inventors), "Non-invasive optical analysis using Surface Enhanced Raman Spectroscopy," Serial No. 60/886,270, filed Jan. 24 (2007).
7. **Mazur, E**., E. Diebold, and T. Baldacchini (inventors), "Polymeric substrates for Raman spectroscopy," Serial No. 60/886,256, filed Jan. 23 (2007).
8. Ristenpart, W.D., J. Wan and **H.A. Stone** (inventors) "A microfluidic approach to measuring enzymatic kinetics," Patent, provisional filing (2007).
9. Schonbrun, E., C. Rinzler, and **K.B. Crozier** (inventors), "Methods and apparatus for on chip trapping with a water immersion zone plate," Serial No. 60/974,479, filed Sep. 23 (2007).
10. **Stone, H.A.**, J. Wan and M. Sullivan (inventors), "Formation of particles for ultrasound application, drug release, and other uses, and microfluidic methods of preparation," Patent provisional filing.
11. **Westervelt, R.M.** (inventor), "Methods and apparatus for manipulation of droplets," Serial No. 60/947,063, Case 70032US00, filed Jun. 29 (2007).
12. **Westervelt, R.M.** (inventor), "Methods and apparatus for near field irradiation," Serial No. US2007/06103, Case 70025WO00 (PCT), Patent filed Mar. 9 (2007).
13. **Westervelt, R.M.** (inventor), "Microscopy methods and apparatus for manipulation and/or detection of biological samples and other objects," Serial No. US2007/000779, Case 70031WO00 (PCT), filed Jan. 12 (2007).
14. **Westervelt, R.M.** (inventor), "New geometry for NMR devices," Serial No. 60/905,254, Case HU2913, Patent filed Mar. 6 (2007).

15. **Whitesides, G.M.** (inventor), "Differential treatment of selected parts of a single cell with different fluid components," Patent 2001292787, awarded May 11 (2007).
16. **Whitesides, G.M.** (inventor), "Forming and using structures in microfluidic channels," Serial No. 61/001,923, filed Nov. 5 (2007).
17. **Whitesides, G.M.** (inventor), "Methods and apparatus for on chip trapping with a water immersion zone plate," Serial No. 60/974,479, filed Sep. 23 (2007).
18. **Whitesides, G.M.** (inventor), "Microfluidic systems including three-dimensionally arrayed channel networks," Serial No. 11/983,425, filed Nov. 8 (2007).
19. **Whitesides, G.M.** (inventor), "Microfluidic systems including three-dimensionally arrayed channel networks," Patent licensed (2007).
20. **Whitesides, G.M.** (inventor), "Patterning of surfaces utilizing microfluidic stamps including three-dimensionally arrayed channel networks," Patent 7,267,938, awarded Sep. 11 (2007).
21. **Whitesides, G.M.** (inventor), "Preparation of mixed SAMs that resist adsorption of proteins using the reaction of amines with a SAM that presents interchain carboxylic anhydride groups," Patent 2001275957, awarded Jul. 5 (2007).
22. **Whitesides, G.M.** (inventor), "Purification of a bivalently active antibody using a non-chromatographic method," Case PCT/US2007/012989, filed June 1 (2007).
23. **Whitesides, G.M.** (inventor), "Surfaces that resist the adsorption of biological species," Patent 7,276,286, awarded Oct. 2 (2007).
24. **Whitesides, G.M.** (inventor), "Synthetic trivalent haptens, complexes Thereof, and uses Therefor," Case PCT/US07/86163, filed Nov. 30 (2007).
25. **Whitesides, G.M.** (inventor), "Systems and methods for a separation using electric fields," 3073tba, filed Nov. 2 (2007).
26. **Zhuang, X.** (inventor), "Granular nanoparticles having bright fluorescence and giant Raman enhancements," Serial No. 60/988,283 (2007).

17. HONORS AND AWARDS, 2007–2008

Joanna Aizenberg

Ronald Breslow Award for the Achievement in Biomimetic Chemistry, American Chemical Society (ACS), 2008
Fellow, American Association for the Advancement of Science (AAAS), 2007
Industrial Innovation Award, American Chemical Society, 2007
Named "Highly Influential Author" by Essential Science IndicatorsSM
Member of the Board on Physics and Astronomy, National Academy of Science (NAS), 2006–present
Member of the Board of Directors, Materials Research Society, 2006–present
Member of the National Academies Committee on Biomolecular Materials and Processes, National Research Council (NRC), 2006–2008

Moungi Bawendi

Langmuir Lecture, American Chemical Society, 2007
Harkins Lecture, The University of Chicago, Department of Chemistry, 2007
Elected Member, National Academy of Sciences, 2007

Cynthia M. Friend

Alexander von Humboldt Award, Humboldt Foundation, 2007–2008

Arthur C. Gossard

Newcombe Cleveland Prize, Best article of the year award in *Science Magazine*, with Charles Marcus *et al.*, 2007

Bertrand I. Halperin

Dannie Heineman Prize (awarded once every two years; covers all fields of Science), Akademie der Wissenschaften zu Goettingen, 2007

Efthimios Kaxiras

Multiscale Modeling of biopolymer translocation through a nanopore: Best Paper in a Workshop award, International Conference on Computational Science (ICCS), 2007

Eric Mazur

New Chair — Balkanski Professorship, 2007
Harvard Australia Fellow, 2007
Phi Beta Kappa, Visiting Scholar, 2007
Baetjer Lectureship, Princeton University, 2007

Venkatesh Narayanamurti

Elected Fellow American Academy of Arts and Sciences, 2007
Member, Engineering Dean's Council, Cornell University, 2003–2008

Member, Engineering Dean's Council, Brown University, 2004–2008
Member, Engineering Dean's Council, Public Policy Committee, American Society for Engineering Education (ASEE), 2005–2008
Member, Center for Integrated Nanotechnologies Board, Sandia National Laboratories, 2005–2008
Member, Mork Family, Department of Chemical Engineering and Material Science Advisory Committee, University of Southern California, 2006–2008
Member, President's Council, Olin College, 2006–2008
Member, Review Committee, Tata Institute for Research, Mumbai India, 2007
Overseer, NRC Report on Future of Condensed Matter and Materials, Physics, 2010, National Research Council, 2007
Member Stokes Programme, Physics Panel, Science Foundation of Ireland, 2007
Chair, Advisory Panel on Light Source Facilities, National Science Foundation, 2007–2008

Hongkun Park

Camille and Henry Dreyfus Teacher-Scholar Award, Dreyfus Foundation, 2003–2008

Howard A. Stone

Chair, American Physical Society, Division of Fluid Dynamics, 11/2006–11/2007
Plenary Speaker, Annual Dutch Physics Meeting, Veldhoven, The Netherlands, January 2007
Stewartson Memorial Lecture, British Applied Mathematics Conference, Bristol, UK, April 2007
Plenary Speaker, MicroTas, Paris, October 2007
G.K. Batchelor Prize in Fluid Mechanics (1st award; given every four years), 2007

Robert M. Westervelt

Director, Board of Advisors, NISE Network of Museums . 2007
Board of Advisors, Center for Integrated Nanotechnologies (CINT), Sandia National Laboratory, 2003–present
Fellow, American Physical Society, 2007

George M. Whitesides

Priestley Medal, American Chemical Society, 2007
August-Wilhelm von Hoffmann Vorlesung, German Chemical Society, 2007

Ziaowei Zhuang

Coblentz Award, Coblentz Society, 2007