August 25, 2007

Albert Polman

1. Resume

Albert Polman (1961) is director of the FOM-Institute for Atomic and Molecular Physics (AMOLF), a research laboratory of the Dutch Foundation for Fundamental Research on Matter (FOM), in Amsterdam, The Netherlands. He also heads the Photonics Materials research group at AMOLF. He is associated with the University of Utrecht as a professor of Nanophotonics and is part-time visiting associate in the Faculty of Applied Physics at the California Institute of Technology (CALTECH), Pasadena, CA.

Polman specializes in studies at the interface between optical physics and materials science, and has regularly demonstrated transfer of fundamental physics knowledge to applied concepts.

Polman received his master's degree in physics (1985) and his Ph.D. degree in materials science and engineering (1989) from the University of Utrecht. From 1989 to 1991 he was a post-doctoral staff researcher at AT&T Bell Laboratories (Murray Hill, NJ). Since 1991 he has been associated with AMOLF, first as a group leader, since 1999 also as a department head, since 2005 as head of the Center for Nanophotonics and since 2006 as director of AMOLF. Polman was one of the initiators of the Amsterdam *nano*Center, a regional facility for nanofabrication founded in 2003. From March 2003 - February 2004 he was on sabbatical leave at CALTECH, where he was a research associate in the group of Prof. H.A. Atwater.

Polman's main research interest is *nanophotonics*, the study of optical interactions in materials that are made using nanoscale fabrication technologies. His research program includes the study of energy transfer in metallo-dielectric plasmonic structures, control of optical modes and spontaneous emission in microcavities, and light emission from silicon using rare earth ions or silicon nanostructures. His group has published 151 articles in refereed international journals and 80 conference proceedings articles. His articles have been cited over 4400 times and his field-averaged citation impact factor is 3.18. Polman is co-inventor on four patents and his group has given over 60 invited talks at international conferences.

Polman is member of the Nanophysics/technology Advisory Board of FOM, program manager of the national FOM research program *Photon Physics in Optical Materials*, program manager of the *Nanophotonics program* of the Dutch National Nanotechnology Program NANONED, and member of the Program Committee for the FOM-Shell program on *Third generation solar cells.* In 2004 he co-initiated the FOM-Philips program *Microphotonic Light Sources.* In 2005, he co-authored the national Nanoscience strategy initiative for FOM/NWO.

As a director of AMOLF, Polman has taken initiatives to concentrate AMOLF's research program in two main directions: Nanophotonics and Physics of Biomolecular Physics. Under his guidance, the institute underwent an international panel evaluation in 2006, at which the institute as a whole and each of the research programs of AMOLF were rated as excellent. Most recently, Polman has steered the institute into a direction where top-quality fundamental research is combined with initiatives to achieve knowledge transfer to industry and society.

Polman is a member of the Editorial Advisory Board of Nano Letters (Americal Chemical Society), the Advisory Editorial Board of Physica B (Elsevier), the Advisory Board of the Photonics Research Institute COBRA of the Technical University Eindhoven, the International Advisory Board of the University of Surrey Ion Beam Centre, the Materials Science Advisory Board of the Research Center Rossendorf (Germany) and the Advisory Board of the Centre of Excellence for Advanced Silicon Photovoltaics and Photonics of the University of New South Wales (Australia). In 2004-2005 he was a member of the Board of Directors of the Materials Research Society (Pittsburgh). In 2007 he was elected member of the Royal Dutch Society of Sciences (Koninklijke Hollandsche Maatschappij der Wetenschappen).

Polman was chairman of the 11^{th} International Conference on Ion Beam Modification of Materials in 1998 and is member of the International Committee of IBMM. He co-organized three symposia at meetings of the Materials Research Society, in 1994 (Boston), 1996 (San Francisco), and 1997 (San Francisco). He was Volume Organizer (editor) for the year-2000 volume of MRS Bulletin. In April 2003 he served as one of the meeting chairs of the MRS Spring Meeting in San Francisco. He was co-chair of the Symposium *Nanophotonic materials* at the European Material Research Society Meeting (Strasbourg, 2004), and is a member of the program committee of the International Conference on Group-IV photonics (Hongkong, 2004; Antwerp, 2005), and of the *Microcavities* subcommittee of the European Quantum Electronics Conference (Munich, 2005). Polman was chairman of the first Gordon Research Conference *Plasmonics - optics at the nanoscale* in 2006.

Albert Polman is married to the musicologist Dr. Philomeen Lelieveldt; they have two children, Philine (10), and Fabian (8).

2. Scientific achievements

Following my Ph.D. research at AMOLF on laser- and ion-beam induced phase transformations in silicon (1985-1989), I started working on optical materials when I was appointed as a post-doctoral research at AT&T Bell Laboratories. Here, I introduced the concept of "optical doping" using ion implantation. I initiated experiments on erbium implantation into a range of dielectric materials and studied the damage annealing and activation of optical dopants. Based on the success of this work, in 1991 I was given the opportunity to start a research group at AMOLF working on rare earth doped optical materials. I then further explored the optical doping technique, applying it to dielectrics and semiconductors. In highly doped dielectrics I studied non-linear optical interactions between rare earth ions that result from Förster energy transfer, and studied the coupling of rare earth electronic states to matrix defects. We were one of the first to carry out optical spectroscopy in optical waveguides, taking advantage of the high continuous-wave pump laser intensity that can be achieved in these structures. We identified cooperative upconversion as the main gain-limiting effect in highly doped optical amplifiers. Our understanding of the optical properties of highly rare earth doped thin films eventually lead to the fabrication of the world's smallest erbium-doped planar optical amplifier, a concept that was commercialized in 2002.

In the meantime, I changed focus to the doping of silicon, where I first pioneered a new non-equilibrium solid-state epitaxial growth method to incorporate high concentrations of the insoluble rare earth ions into the semiconductor host. I then studied the opto-electronic coupling between the 4*f* electronic states of rare earth ions and the rare-earth related electronic defect states in the semiconductor bandgap. Together with my collaborators from the University of Catania, I identified an Er-O cluster configuration that lead to optimum light emission from Er-doped Si. Subsequently, we developed the first room-temperature light emitting diode based on Si:Er. Altogether, I believe I am the pioneer of rare earth doping of thin film dielectrics and semiconductors, and of the study of optical interactions in these materials. Indeed, many research groups worldwide have followed my group on this topic. In 2003, I spent a sabbatical at CALTECH, working a full year in the lab. Together with my collaborators in Vahala's group, I developed the world's smallest rare earth doped microcavity laser on silicon, based on an ultra-high Q Er-implanted toroidal silica cavity, entirely made using CMOS-compatible processing steps.

Fermi's Golden Rule tells that the emission rate from an optical emitter is determined by the final optical density of states. In order to achieve control over this property, in 1994 I started experiments on modifying the dielectric environment around optical emitters. By modulating the local density of states near a dielectric interface we were able to demonstrate variations in the radiative decay rate of rare earth ions, transition metals, and most recently Si quantum dots. We further explored this concept to identify non-radiative decay processes, which are often difficult or impossible to independently determine. In collaboration with Sandia National Laboratories we were the first to demonstrate modified spontaneous emission in a three-dimensional photonic crystal with a full photonic bandgap, using a Si photonic woodpile structure. We were also able to demonstrate that Förster energy transfer is not modified by the local optical density of states.

As a side track along optical experiments, I have always kept an interest in trying to understand the fundamentals of ion-solid interactions. Indeed, with my background in ion implantation, I was able to fabricate optical materials or structures that are otherwise impossible to make. Using an *in-situ* wafer-curvature measurement technique, that probes mechanical stress in a thin film during ion irradiation, we were able to distinguish, on a microscopic scale, the effects of radiation-induced Newtonian viscous flow, anisotropic deformation, and point defect generation and annihilation that all occur during ion irradiation of silica glass. We were the first to relate macroscopic parameters to microscopic phenomena that occur in the picosecond thermal spike of the nanoscale ion track. Most recently, we identified for the first time the role of capillary forces in shape changes of nanoscale objects under ion irradiation.

All along in my research, silicon has been an important base material. Achieving light emission from silicon is one of the holy grails of opto-electronic technology, and my group has played a key role in establishing this research field worldwide. Together with the group of Atwater at CALTECH, I pioneered a novel way to fabricate optically active Si quantum dots in a SiO_2 matrix. We identified the radiative and non-radiative components in excitonic transitions in these nanostructures. Our knowledge lead to the design of a non-volatile electronic memory structure based on Si quantum dots. Combining the field of erbium doping and Si photonics we were the first to demonstrate efficient coupling between excitonic states in semiconductor nanostructures and the 4*f* electronic shells of the rare earth ions.

Most recently, I have redirected my group's research activities towards plasmonics, the manipulation of light using metallic nanostructures. We have demonstrated coupling between optically active erbium ions and Si quantum dots to surface plasmon polaritons (SPPs) on silver metal films. We have developed a near-field optical microscopy imaging technique to study the propagation, damping and dispersion of SPPs at length scales below the diffraction limit. Using specially designed plasmon tapers we demonstrated non-linear optical effects at the taper tip. We now explore this idea to enhance the infrared sensitivity of silicon solar cells. We also developed cathodoluminescence imaging spectroscopy as a novel technique to study plasmonic phenomena at nanoscale resolution. We observed localized modes and strong dispersion in Ag nanowires and nanoresonators using this technique. Using electron-beam lithography we have fabricated nanoscale optical waveguides based on dipole coupling between metal nanoparticles. Furthermore, we observed an unexpected behavior in the dispersion of these waveguides, that leads to frequency tunable localization of energy along the arrays. We also studied the coupling between individual nanoparticles and optical emitters such as Si quantum dots and erbium ions. Strong local field enhancements in engineered nanostructures lead to enhanced and polarization-controlled photoluminescence as well as electroluminescence. Our most recent activities focus on using DNA molecular templating techniques to assemble plasmonic nanostructures with unique (bio-)sensing properties.

Altogether, I have carried out pioneering studies on the atomic and molecular engineering of rare-earth doped) dielectric, semiconductor and metallic photonic nanostructures, and on the identification of novel energy transfer processes in these materials.

3. Knowledge transfer

Collaborating with industrial partners and transferring knowledge has always been a key part of my work. In the past years I have interacted with the following industrial partners.

AT&T Bell Laboratories
From 1989-1991 I worked a post-doctoral researcher at AT&T Bell Laboratories in the group of Dr. John Poate. Here I learned the technical principles of optical telecommunication. At Bell Labs I also learned how fundamental research can go hand in hand with technical innovations. I published 7 articles with AT&T, and am co-inventor on one patent with AT&T.

Symmorphix

Symmorphix is a small company in Sunnyvale (Silicon Valley), CA, that was founded to commercialize a planar optical amplifier, entirely based on a prototype developed in my group at AMOLF. The company rose an amount of 40 M€ in venture capital to achieve this. The product, which came on the market in 2002, was developed in an intense collaboration with AMOLF. Symmorphix (Dr. Ernest Demaray) funded two Ph.D. students in my group, we did several paid services for them and, as a consultant, I held weekly conference calls with Symmorphix to guide their research and development activities. I am co-inventor on one patent with Symmorphix.

ST Microelectronics

In 1993, I started a collaboration with ST Microelectronics (Catania, Italy) on Si-based opto-electronics. We developed the first room-temperature light emitting diode based on Si, and the first Er-doped Si infrared detector. ST had no optical characterization capabilities at that time, and my optical laboratory at AMOLF played a central role in this collaboration. Because of the success of the joint research with AMOLF, my collaborator at ST (Dr. Salvo Coffa) was able to initiate a large photonics activity at ST, that he now heads (60 researchers). ST built an exact copy of the optical characterization laboratory that was developed at AMOLF. Recently, ST has purchased from Symmorphix a complete facility for the fabrication of planar Er-doped optical amplifiers. I published 1 article with ST, and am co-inventor on two patents with ST.

CALTECH/Intel Corporation

In 1993, I started collaborating with CALTECH (Prof. Harry Atwater). Through our collaboration, we developed a method to fabricate Si nanocrystals embedded in an MOS transistor that can then be used as a non-volatile memory in which charge is stored in the quantum dots. Intel Corporation is now developing a prototype of this device (Dr. George Bourianoff). Two of my Ph.D. students went to CALTECH as post-docs and continued working with Intel on this topic. Most recently, we demonstrated an improvement of the electroluminescence of devices processed at Intel, by using specially engineered metal nanostructures fabricated at AMOLF. In 2003, I was invited to give a plenary presentation at the yearly meeting of the Semiconductor Research Corporation (USA) that brings together all “forward-looking research” specialists of the large semiconductor companies in the USA.

Philips

In 2003, I helped establish the Industrial Partnership between FOM and Philips (Dr. Eric Meulenkamp). I helped draft the research program and I am now regularly traveling to Eindhoven to discuss work. Vice versa, researchers from Philips now regularly travel to AMOLF to use specialized equipment that is not available at Philips. I have expressed FOM’s ambition to contribute to the Dutch knowledge economy in a video testimonial that is published on the website of the High Tech Campus in Eindhoven (http://www.hightechcampus.nl/campus/testimonials/).

Shell

The FOM-Shell industrial partnership program finances innovative research projects on third-generation photovoltaic solar cells. My group carries out a research projects within this program, and knowledge will be transferred to Shell. Most recently, I started a second project on plasmon-enhanced solar cells that is fully sponsored by Shell. I published one article within this program.

TNO

Triggered by our work on Er-doped Al_2O_3 optical amplifiers, TNO (Dr. Anne-Jans Faber) developed in interest to collaborate with us on Er-doped silica glass amplifiers. Together with TNO we fabricated a device with (until today) world-record gain per unit length. I published 1 article with TNO.

ECN

ECN possesses world leading facilities for the fabrication and characterization of Si solar cells. Our work on Er-doped Si triggered an idea to enhance the infrared response of Si solar cells, that was subsequently demonstrated together with ECN (Prof. Wim Sinke) and the Centre for Advanced Silicon

Photovoltaics of the University of New South Wales (Australia, Prof. Martin Green). I published 1 article with ECN.

KPN
Our initial work on optical doping of silica-based waveguide materials was carried out together with the Dr. Neher research laboratory of KPN (Dr. Mart Diemeer), within the IOP-Electro optics program of the Ministry of Economic Affairs. I published 1 article with KPN.

AKZO-Nobel
Our initial work on optical doping of polymer waveguide materials was carried out together with the AKZO Nobel Research (Dr. Hans Hofstraat). With Hofstraat's transfer to Philips, collaboration on this topic later continued with Philips. I published 2 articles with AKZO and 3 with Philips.

New collaborations
Regularly, fundamental research in my group leads to new devices concepts. In cases we do not know an industrial partner to transfer this knowledge to, we publish our ideas on our website (www.erbium.nl/device_ideas), in order to raise interest of possible users.

4. Academic collaborations

Since my start as a group leader at AMOLF in 1991, I have established the following academic collaborations.

Utrecht University
For the synthesis of colloidal nanomaterials we collaborate with Prof. Alfons van Blaaderen. Sofar, we have published 15 papers together, and we jointly supervise a Ph.D. student. Some of our ion irradiation studies were carried out with the tandem accelerator at Utrecht University, in collaboration with Dr. Arjen Vredenberg (6 joint papers). A FOM project awarded to AMOLF provided funding to construct an ion implantation beam line at this machine.

Groningen University
In conjunction with experiments in my group, theoretical work on Förster energy transfer and local optical density of states is carried out by Prof. Jasper Knoester at Groningen University (1 joint paper). Continuum mechanical modeling of ion-solid interactions is being carried out with the group of Prof. Erik van der Giessen (2 joint papers).

Leiden University
In conjunction with experiments in my group, theoretical work on the local optical density of states in dielectric materials is carried out by Dr. Michiel de Dood at Leiden University (1 paper).

University of Amsterdam
I have established the Amsterdam *nano*Center, a regional facility for nanofabrication and characterization in 2003, together with Dr. Jeroen Goedkoop from the University of Amsterdam. Since then, many users from the University of Amsterdam have used the cleanroom for sample fabrication.

Eindhoven University of Technology
Experiments on local field effects in Er-doped materials are carried out together with the group or Prof. Richard van de Sanden, who developed an ultra-sensitive cavity ring-down system to determine optical absorption cross sections (1 joint paper).

Technical University Twente
We characterized and optimized rare-earth doped organic cage complexes together with the group of Dr. Frank van Veggel and Prof. David Reinhoudt (7 joint papers).

Technical University Delft

Our first Er-doped Al_2O_3 planar optical waveguide samples were made using fabrication technology developed by Prof. Meint Smit (5 joint papers). Novel reactive ion etching techniques for the fabrication of two-dimensional Si photonic crystals were developed together with the group of Dr. Emile van der Drift (3 joint papers).

Research Center Jülich, University of Catania
I carried out a joint research program on Si-based opto-electronics, funded by the European Union, together with Dr. Chris Buchal (Research Center Jülich, 2 joint papers), and Dr. Salvo Coffa and Dr. Francesco Priolo (University of Catania, 6 joint papers).

Cambridge University
Together with the group of Prof. Richard Friend we developed the first infrared polymer light emitting diode (1 joint paper).

Marie Curie Training institute
Our group was awarded a research project within a Marie Curie Early Stage Research Training program, awarded to AMOLF in 2005. We are now an official EU training site for Ph.D. students that carry out research at the interface between nanophotonics, biophysics and femtophysics.

California Institute of Technology
In 1993, I started a collaboration with CALTECH (Prof. Harry Atwater). The collaboration is still ongoing: I spent a sabbatical leave at CALTECH in 2003-2004; Atwater was AMOLF's Joop Los Fellow in 2005, and students of our two group travel back and forth between AMOLF and CALTECH on a regular basis. We have published 17 papers together, and have also published joint opinion articles in Materials Today and MRS Bulletin. During my sabbatical, I also worked with the group of Prof. Kerry Vahala on ultra-high Q Er-doped microlasers on silicon (4 joint papers).

Multidisciplinary Research Initiative (MURI)
Our group is awarded a research project in a Multidisciplinary University Research Initiative" (MURI) based in the United States. In this network CALTECH, Harvard University, the University of California at Los Angeles (UCLA), the University of San Diego and en Berkeley University collaborate on surface plasmon nanophotonics. AMOLF is one of the two European partners in this program.

5. Projects funded

In the period 1991-2007, I have written a total of 33 research proposals. 31 proposals were granted immediately; 2 were granted after they were re-submitted a second time. My overall proposal success rate is thus 100%. The total amount of external funding I attracted since 1991 is M€ 10.4.

1	STW	Modification of optoelectronic materials using MeV ion implantation	1992-1993	k€ 197
2	IOP	An Integrated optical amplifier	1993-1994	172
3	FOM Wg-Ha	Optical doping of silicon by MeV rare earth ion implantation	1993-1995	176
4	STW	Modification of optoelectronic materials using MeV ion implantation II	1994-1995	145
5	FOM Wg-GM	Nanoclusters in optical waveguides	1994-1996	154
6	FOM Wg-GM	Silicon nanoclusters	1994-1996	152
7	NATO	Collaborative research grant	1995-1996	6
8	IOP Electro-Optics	An Integrated optical amplifier	1995-1996	40
9	STW	Si-based optoelectronic materials	1995-1999	499
10	NATO	Collaborative research grant	1996-1997	6
11	ESPRIT	Silicon-compatible optoelectronics	1996-1997	27
12	FOM Wg-GM	Rare earth doped polymer waveguides and LEDs	1996-1998	175

13	FOM Wg-GM	Nanostructured optical waveguide materials	1996-1998	390
14	IOP Electro-Optics	An Integrated optical amplifier	1997-1999	67
15	NWO	Solar Cells for the 21st century	1997-1999	113
16	ESPRIT	Silicon-compatible optoelectronics	1997-2001	524
17	FOM-IGM	Ion beam analysis of materials	1998-2000	25
18	FOM program PPOM	Silicon-based microphotonics	1999-2001	315
19	Symmorphix	Rare earth doped optical waveguides - 2 projects	2001-2002	145
20	FOM program IGM	Rutherford backscattering analysis facility	2001-2003	145
21	Projectruimte 2001	Colloidal particles with continuously variable shape	2002-2005	259
22	FOM Program PPOM	Si microphotonics, continuation	2002-2005	60
23	FOM Program PPOM	Nanophotonic interactions	2002-2006	535
24	FOM infrastructure	Amsterdam nanoCenter	2002-2004	2768
25	Nanoimpuls	Photonic transistor	2002-2006	304
26	Projectruimte 2004	Surface plasmon nanophotonics: How small can a photon be shrunk?	2004-2008	298
27	NANONED	Nanoscale energy transfer in photonic nanomaterials	2004-2008	291
28	FOM-Shell IPP Program	Rare earth doped surface plasmon solar upconverter	2005-2009	333
29	NANONED	Nanophotonics optical characterization investments	2005-2008	355
30	MURI (USA)	Surface plasmon enhanced Si:Er LEDs	2005-2007	186
31	NWO-Groot	Nanofabrication for Nanophotonics investment grant	2006-2007	2.500
32	NANONED	Nanophotonics valorisatie	2006-2009	157
33	Shell	Plasmonic solar cells	2007-2008	100
34	GCEP	Plasmonic photovoltaics	2007-2010	401
	TOTAL			**M€ 11.2**

6. Supervision of Ph.D. students

I have supervised 11 Ph.D. students who have finished their Ph.D.:

1. *Optical doping of silica by erbium ion implantation*
   E. Snoeks, Ph.D. Thesis Utrecht University, April 26, 1995
2. *Erbium-doped photonic materials based on silicon*
   G.N. van den Hoven, Ph.D. Thesis Utrecht University, January 10, 1996
3. *Optical properties of ion beam synthesized Si nanocrystals in SiO2*
   M.L. Brongersma, Ph.D. Thesis Utrecht University, June 15, 1998
4. *Energy transfer in erbium-doped optical waveguides based on silicon*
   P.G. Kik, Ph.D. Thesis Utrecht University, September 18, 2000
5. *Rare earth doped polymer waveguides and LEDs*
   L.H. Slooff, Ph.D. Thesis Utrecht University, November 17, 2000
6. *Optical properties of ion beam modified waveguide materials doped with erbium and silver*
   C. Strohhöfer, Ph.D. Thesis Utrecht University, December 10, 2001
7. *Silicon photonic crystals and spontaneous emission*
   M.J.A. de Dood, Ph. D. Thesis Utrecht University, April 11, 2002
8. *Ion irradiation-induced anisotropic plastic deformation*
   T. van Dillen, Ph. D. Thesis Utrecht University, April 26, 2004
9. *Controlled spontaneous emission in erbium-doped microphotonic materials*
   J. Kalkman, Ph. D. Thesis, Utrecht University, April 9, 2005
10. *Tunable plasmon resonances in anisotropic metal nanostructures*
    J.J. Penninkhof, Ph. D. Thesis, Utrecht University, September 25, 2006

11. *Controlling plasmon-enhanced luminescence*
H. Mertens, Ph. D. Thesis, Utrecht University, April 25, 2007

Presently, I supervise a total of 5 Ph.D. students and 3 post-docs. In addition, in the past years, I have supervised a total of 17 undergraduate students who have graduated at various Dutch universities.

7. Teaching

Since 1996, I am appointed as an adjunct professor at the Debye Institute at Utrecht University. My inaugural lecture in 1998, entitled "The Optical Chord" demonstrated the relation between optical phenomena in nanomaterials and the musical scale.

At Utrecht University I first set up a new course for 4th and 5th year students on "Thin film analysis". I have given this course nearly yearly from 1996-2002. I have also developed a new teaching method, in which my lecture is composed of 6 "lecture clips" of 15 min each, based on the presumption that the typical student's attention span is roughly 15 min. The new method was published in the Journal of Materials Education and has served as an example to teachers at Utrecht University and the University of Amsterdam. The students' rating for my course was always between 8 and 9.

In September 2005 I started a new course "Nanophotonics" at Utrecht University that covers fundamental aspects and applications of nanophotonics. The latest rating of this course (January 2007) was 8.

8. Citations

I have published 151 scientific articles in peer-reviewed international journals and 80 articles in conference proceedings. The articles have been cited over 4400 times. A citation analysis by the Center for Science and Technology Studies of Leiden University in 2006 showed a field-averaged citation impact factor of my articles of 3.18. Presently, nine articles received more than 100 citations; my most highly cited paper has 427 citations.

9. Patents

I am co-inventor on four patents, all in collaboration with industrial partners:

1. *Apparatus comprising an optical gain device, and method of producing the device* (with AT&T, 1991)
G.E. Blonder, D.C. Jacobson, R.C. Kistler, J.M. Poate and A. Polman
2. *Electro-luminescent material, solid state electro-luminescent device and process for fabrication thereof* (with ST Microelectronics, 1993)
S.U. Campisano, S. Lombardo, G. Ferla, G.N. van den Hoven and A. Polman
3. *Infrared detector device of semiconductor material and manufacturing process thereof* (with ST Microelectronics, 1999)
A. Polman, N. Hamelin, P.G. Kik, S. Coffa, M. Saggio, and F. Frisina
4. *Silver-sensitized erbium-doped planar waveguide amplifier* (with Symmorphix, 2003)
C. Strohhöfer, and A. Polman

10. Publications

A listing of my publications in peer-reviewed international journals is given below (situation August 25, 2007):

1. *Direct observation of plasmonic modes in Au nanowires using high-resolution cathodoluminescence spectroscopy*
E.J.R. Vesseur, R. de Waele, M. Kuttge, and A. Polman, Nano Lett. **7**, (2007), in press
2. *Plasmon-enhanced photoluminescence of silicon quantum dots: simulation and experiment*
J.S. Biteen, L.A. Sweatlock, H. Mertens, N. Lewis, A. Polman and H.A. Atwater, J. Phys. Chem. C **111** (2007), in press
3. *Ultrafast optical switching of three-dimensional Si inverse opal photonic bandgap crystals*
T.G. Euser, H. Wei, J. Kalkman, Y. Hun, A. Polman, D.J. Norris, and W.L. Vos, J. Appl. Phys. **102** (2007), in press
4. *Plasmon-enhanced luminescence near noble-metal nanospheres: comparison of exact theory and an improved Gersten and Nitzan model*
H. Mertens, A.F. Koenderink, and A. Polman, Phys. Rev. B **75** (2007), in press

5. *Tunable nanoscale localization of energy on plasmon particle arrays*
R. de Waele, A.F. Koenderink, and A. Polman, Nano Lett. **7**, 2004 (2007), also highlighted in Nature **448**, 141 (2007)

6. *Programmable nanolithography with plasmon nanoparticle arrays*
A.F. Koenderink, J.V. Hernandez, F. Robicheaux, L.D. Noordam, and A. Polman, Nano Lett. **7**, 745 (2007)

7. *Enhanced non-linear optical effects with a tapered plasmonic waveguide*
E. Verhagen, L. Kuipers and A. Polman, Nano Lett. **7**, 334 (2007)

8. *Polarization-selective plasmon-enhanced Si quantum dot luminescence*
H. Mertens, J.S. Biteen, H.A. Atwater, and A. Polman, Nano Lett. **6**, 2622 (2006)

9. *Plasmon-enhanced erbium luminescence*
H. Mertens and A. Polman, Appl. Phys. Lett. **89,** 211107 (2006)

10. *Demonstration of an erbium-doped microdisk laser on a silicon chip*
T.J. Kippenberg, J. Kalkman, A. Polman, and K. Vahala, Phys. Rev. A **74**, 51802 (2006)

11. *Size-dependent ion-beam induced anisotropic deformation at the nanoscale by nonhydrostatic capillary stresses*
T. van Dillen, E. van der Giessen, P. R. Onck, and A. Polman, Phys. Rev. B **74**, 132103 (2006)

12. *Complex response and polariton-like dispersion splitting in periodic metal nanoparticle chains*
A.F. Koenderink and A. Polman, Phys. Rev. B **74**, 033402 (2006)

13. *Direct imaging of propagation and damping of near-resonance surface plasmon polaritons using cathodoluminescence spectroscopy*
J.T. van Wijngaarden, E. Verhagen, A. Polman, C.E. Ross, H.J. Lezec, and H.A. Atwater, Appl. Phys. Lett. **88**, 221111 (2006), also highlighted in Science **312**, 1719 (2006)

14. *Fabrication and characterization of erbium-doped toroidal microcavity lasers*
J. Kalkman, A. Tchebotareva, and A. Polman, T.J. Kippenberg, B. Min, and K. J. Vahala, J. Appl. Phys. **99**, 083103 (2006)

15. *Photoluminescence quantum efficiency of dense silicon nanocrystal ensembles in SiO_2*
R. J. Walters, J. Kalkman, A. Polman, H. A. Atwater, and M. J. A. de Dood, Phys. Rev. B **73**, 132302 (2006)

16. *Depth-resolved nanostructure and refractive index of borosilicate glass doped with Ag nanocrystals*
H. Mertens and A. Polman, Optical Materials **29**, 326 (2006)

17. *Erbium luminescence imaging of infrared surface plasmon polaritons*
E. Verhagen, A. Tchebotareva, and A. Polman, Appl. Phys. Lett **88**, 121121 (2006)

18. *Spectral tuning of plasmon-enhanced silicon quantum dot luminescence*
J.S. Biteen, N. Lewis, H.A. Atwater, H. Mertens, and A. Polman, Appl. Phys. Lett. **88**, 131109 (2006)

19. *Excitation of surface plasmons at a SiO2-Ag interface by silicon quantum dots: Experiment and theory*
J. Kalkman, H. Gersen, L. Kuipers, and A. Polman, Phys. Rev. B **73**, 075317 (2006)

20. *Plasmon slot waveguides: towards chip-scale propagation with subwavelength-scale localization*
J.A. Dionne, L. Sweatlock, H.A. Atwater, and A. Polman, Phys. Rev. B **73**, 035407 (2006)

21. *Erbium-implanted silica microsphere laser*
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