Nasir Basit, PhD

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EDUCATION

Ph.D. in Electrical Engineering, University of Pittsburgh **1993-1998**
M.S. in Electrical Engineering, University of Pittsburgh **1991-1992**
B.E. in Electronics Engineering, N.E.D. University **1983-1987**

EXPERIENCE

Northwestern University, Evanston, IL **7/2008-Present**
Director of Operations, NUFAB
NUFAB or Northwestern University Micro/Nano Fabrication Facility consists of 6,000 ft^2 class 100 cleanroom and associated offices in Technological Institute, and 2,000 ft^2 class 100 cleanroom and associated offices in Cook Hall.
http://nufab.northwestern.edu/

Work on starting a new cleanroom nanofabrication facility started at Northwestern with my hiring on July 1, 2008. The milestones achieved since then are listed in chronological order below:

Started Refurbished Cleanroom **2008-2013**
-Fully overhauled, including HEPA filters replacement, 1,000 ft^2 existing non-functional cleanroom and equipped with all new microfabrication tools. Hence, named it NUFAB (pronounced 'new fab')
-The tools included lithography spin-coat and develop benches, mask aligner Suss MABA6, UV flood exposure system, Blue M convection ovens, point of use DI water systems, SPTS DRIE, SPTS PECVD, AJA Orion sputter, Denton thermal evaporator, SCS Parylene coater, Samco RIE, electrical test station, Filmetrics reflectometer, Nikon optical microscopes, and Dektak 8 stylus profilometer.
-Developed safety and protocol training, and training documents for all the tools.
-Conducted all trainings and developed customized processes for users' fabrication and characterization needs.
-Fully operated the cleanroom facility till the Fall of 2013 when it moved to the new construction.

Making of a New Cleanroom Facility **2008-2013**
-Planned for a new construction of cleanroom and associated space in over 7,000 ft^2 infill area of Technological Institute
-Contributed to all design aspects of a new 6,000 ft^2 class 100 cleanroom by regularly attending design and construction meetings with architects, contractors, and consultants over the period of 4 years
-Oversaw the whole construction project of the new clean room working with Facilities Management and Office of Research Safety
-Designed and supervised the phased move of the equipment from old to the new cleanroom with no downtime.
-Developed facility usage and safety procedures

Overseeing the Growth **2013-present**
-Played an important role in bringing several highly active research groups and many junior faculty members to Northwestern by showcasing well-managed, highly successful cleanroom facility with state-of-the-art tools.
-Hired several highly qualified full and part-time employees with good retention rate. Currently, four full-time employees with PhDs and one full-time employee with BS directly report to me.

- Developed business and strategic plans under the guidance of faculty advisory committee and served on task forces assembled time to time by Office of Research for major improvements or upgrades
-Investigated new tools for emerging research at NU
-Wrote many successful internal and external proposals for funding new fabrication tools
-These tools have been added since 2013- 3D Optical Profiler – Zygo nexview, Atomic Force Microscope – Bruker Edge, Contact Angle Measurement – VCA Optima XE, Spectroscopic Ellipsometer – J.A. Woollam alpha-SE, Thin Film Stress Measurement System – FLX 2320-S, Atomic Layer Deposition – Arradiance GEMStar XT-P, E-beam Evaporator – AJA, Parylene Coater – SCS Labcoter2 (2^{nd} system), Sputter II – AJA Orion, Plasma Cleaner – Samco PC-300, Xenon Difluoride Etcher – Xactix, Annealing Furnace – Blue M Doping/Oxidation – Tystar TYTAN Mini Four Stack Horizontal Tube Furnace (Bank 1 – atmospheric). LPCVD Nitride – Tystar TYTAN Mini Four Stack Horizontal Tube Furnace (Bank 2 – low pressure). Rapid Thermal Processor – AW-610, Automatic Develop System – Osiris UNIXX S 20 D, Mask Aligner – Suss MJB4, Maskless Aligner – Heidelberg MLA150, Maskless Aligner – Heidelberg uPG501, Vacuum Oven – YES, High-performance e-beam Writer – Raith VOYAGER 100, Automatic 'Dry In/Dry Out' Acid Etch System – Osiris CHEMIXX MASK 30 E, Critical Point Dryer – Tousimis Automegasamdri – 915B, Series C

-**2018 Cleanroom Expansion:** 1000 ft^2 of space was added to NUFAB to accommodate new deposition/etch tools including wet etching.
-2021 Cook Cleanroom Integration for Emerging Research: Invited to integrate and manage 2000 ft^2 cleanroom and associated office spaces in Cook Hall. This cleanroom has basic lithography, deposition/etch, dicing and characterization (Hall measurement) facilities. Many non-functional tools have been removed to make space for new **Quantum Initiative** at Northwestern. One niobium sputter tool has been purchased and installed, one multi chamber evaporation tool is coming in early 2024 and an oxide etcher is planned for 2024 also. A new photolithography bench has already been installed.

National Nanotechnology Coordinated Infrastructure (NNCI)
-Served on safety committee as a leader for 3 years. Now serving as a member for the last 3 years.
-Pursued outreach activities and conducted facility tours to attract external industrial users and advertise the facility internally and externally

Classes Taught **2008-present**
-Taught every year a first year graduate/senior undergraduate level course on microfabrication offered by mechanical engineering department (ME382) and supervised all the labs in NUFAB clean room

University of Texas at Arlington, Nanotechnology Research Center
It consists of 10,000 ft^2 class 100 cleanroom with additional SEM, FIB, ebeam writer , and characterization labs in its own building.
https://shimadzuinstitute.org/centers/nanotechnology-research-center/

Manager, Nanotechnology Research Center **2/2007-6/2008**
Clean Room Manager **9/2006-1/2007**
Research Engineer **3/2002-9/2006**
I worked for UTA for over 6 years with increasing responsibility reaching to the position of the manager of the center in a short time. As manager I supervised 4 full-time and one half-time technical employees (one with PhD, one with MS, and two with BS), and 3 half-time graduate student workers.
Research:
-Worked on research projects in the area of nanotechnology
-Developed innovative applications and processes on sate-of-the-art equipment
Management and other:
-Contributed to the strategic plan of the center

-Designed equipment training and trained users on specialized equipment
-Designed and conducted clean room safety and protocol training
- Identified equipment need and designed specifications for new equipment
-Supervised equipment installation and verified specifications
-Supervised training/process, maintenance, and repair staff and student employees
-Oversaw day-to-day operation of the clean room

University of Texas at Arlington, Department of Electrical Engineering
Adjunct Faculty **2002**
Taught independently junior/senior undergraduate level microelectronics course with associated labs

Texas A&M University System, NanoFAB Center, TEES
Post-doctoral Research Associate 1999-2002
-Research Projects: Lattice-matched dielectrics on Si, Si RTDs, advanced dielectrics for gate material
-Project Management: Project scheduling and need analysis, equipment identification, specification analysis, and equipment requisition. Train and supervise graduate and undergraduate student employees.
-Cleanroom Experience: Experimental work done in class 1000 clean rooms
-Electrical Characterization: I-V, C-V, C-T, and DLTS
-Atomic Force Microscopy: Traditional and innovative uses of AFM
-X-ray Diffraction: Rocking curve, Lang, Theta-2 theta, glancing angle
-Optical Characterization: n&k, Ellipsometer, photoluminescence, photo-current
-Computer Automation: For electrical measurements using HP-VEE and LabVIEW
-Equipment Installation and Maintenance: RF Sputtering, IV/CV, AFM, PlasmaQuest PECVD and Sputter, RIE, MBE, thermal and e-beam evaporators, SEM, etc.
-Computer: Origin, Mathematica, MS Office

University of Pittsburgh, Department of Electrical Engineering
Research/Teaching Fellow 1993-1998
-Thin film process development by RF sputtering
-Microelectronic Fabrication: Photolithography, plasma/chemical etching and lift-off, metal evaporation, impurity diffusion, etc.
-Electrical Characterization: I-V, C-V, Four-point probe, Hall-effect
-Material Characterization: Thickness (alpha-step), structure (XRD), surface analysis (Nomarski phase contrast microscope, SEM), chemical composition (EDAX)
-Optical Characterization: Integrated waveguides and films.
-Equipment Design and Maintenance: RF Sputtering and other support equipment.
-Computer: MS Office, Mathematica, MathCAD, MatLab, SPICE, AutoCAD, VHDL, MAGIC, AXUM,C, FORTRAN, BASIC.
-Projects: Ferroelectric films and ferroeletric field effect transistors.
-Teaching/grading graduate and undergraduate courses in semiconductor electronics and electronics labs.

Akhter Computers Inc.
Computer Hardware Engineer 1989-1990
Maintenance of IBM and IBM compatible PCs and, design and repair of PC power supplies.

AWARDS AND ACHIEVEMENTS

-Fellowship for Ph.D. in Electrical Engineering
-Several merit scholarships for undergraduate and graduate education

JOURNAL REVIEW AND PROFESSIONAL MEMBERSHIPS

-Reviewer of several journals over the years
-Member, IEEE
-Member, APS

WORK AND RESEARCH CONTRIBUTIONS at UTA

Research Equipment

Zeiss 1540 Cross Beam with Nabity Electron Beam Writer **2002**

Key Specifications:
-Focused Ion Beam (FIB) system with e-beam and ion beam writing
-Orsay Electronics' FIB gun
-Three- gas injection system for Tungsten and SiO2 deposition and Si, SiO2 and SiN etching
-Kleindiek manipulator for TEM sample preparation
-Zeiss thermal field-emission SEM with Gemini column and, in-lens and SE2 detectors
-Nabity system for electron beam and ion beam writing with electrostatic beam blanker (Raith)

<u>My Contributions:</u>
I designed the specifications listed above for this equipment based on the future needs of nanotechnology research and the current researchers' inputs. Initially the idea was to have an SEM based electron beam writing tool to generate nano-sized patterns for research. I was able to convince the higher management to add focused ion beam column to it. The key factor that I suggested to make this instrument unique was integration of this column with the electron beam writer so that with this instrument we could not only write patterns with electron beam but also with ion beam. An interesting feature of ion beam writing is that it can generate etching as well as deposition patterns and these patterns can be observed live with electron beam imaging. The same is not true for e-beam writing. Currently, I am writing FIB and ebeam patterns, and doing analysis with FIB for several projects. We are preparing to start TEM sample preparation soon.

Zeiss Supra 55VP with EDAX Genesis 4000 **2002**

Key Specifications:
-Cold field-emission scanning electron microscope (SEM) with x-ray microanalysis
-Supra 55VP Gemini column
- Big chamber to load up to 8" wafer
-In-lens and SE2 detectors, VPSE detector for insulating samples, and four-quadrant BSE detector
-Built-in electrical feedthroughs to the chamber for MEMs work.
-Genesis 4000 XMS system energy dispersive spectrometer including a sapphire detector with digital signal processing, x-ray mapping and digital imaging for SEM

<u>My Contributions:</u>
We needed an SEM for nanotechnology work. So, I chose cold-field emitter and Gemini column for highest resolution (1 nm). Variable pressure detector (VPSE) and chamber were added for observing insulating samples without coating. Genesis 4000 was added to have the state of the art EDS characterization. Low-noise rooms were built for this instrument and 1540 Cross Beam. I took part in the design, and specification verification of these rooms. I did SEM measurements for various types of samples and conducted the user training and qualification.

RHK Technology UHV 3000 **2003**

Key Specifications:
-Variable temperature UHV STM (ultra high vacuum scanning tunneling microscope)
-Turn-key system with surface preparation chamber. Vibration isolated console assembly. Bake out system. SPM chamber pumping system. Loadlock chamber pumping system.

-Customized system with evaporation and surface preparation sources in preparation chamber and LEED
My Contributions:
This system was designed for multipurpose use. However, one key application was in-situ Se passivation of silicon surfaces and their observation with UHV STM. I took part in designing specifications, system configuration, sample holders etc.

TRION DRIE Etch System **2004**
Key Specifications:
DRIE reactor with 8” bottom electrode and radially designed plenum
Vacuum load-lock-includes load-lock, gate valve, robot and dry pump
Five mass flow controllers inside vented enclosure (SF_6, O_2, He, Ar, CF_4)
Automatic pressure control
Automatic tuning with 600 watt, 13.56 MHz RF generator
8Kw X-tream Source, Electrostatic chuck with helium backside cooling
Processes installed for etching Si, SiO_2, Si_3N_4, polymers and photoresist
My Contributions:
Designed specifications and comparatively studied systems from various manufacturers
Worked with the manufacturer on system requirements and design.

TRION ORION II PECVD/LPCVD SYSTEM **2004**
Key Specifications:
Stainless steel reactor with 8" bottom electrode and radially designed plenum.
Three mass flow controllers inside vented enclosure (CF_4, N_2O, N_2).
300 Watt, 100 kHz solid state power supply, 600 watt, 13.56 MHz RF generator, Vacuum load-lock
Processes installed for deposition of polysilicon, amorphous silicon, silicon nitride and silicon dioxide.
My Contributions:
Designed specifications and comparatively studied systems from various manufacturers
Worked with the manufacturer on system requirements, design, and chemical safety aspects

TRION MINILOCK II RIE ETCH SYSTEM **2004**
Key Specifications:
Minilock II RIE reactor with 8” bottom electrode and radially designed plenum
Vacuum load-lock-includes load-lock, gate valve, robot, and a dry pump
Automatic tuning with 600 watt, 13.56 MHz RF generator
Processes installed for etching InP, GaAs and AlGaAs
My Contributions:
Designed specifications and comparatively studied systems from various manufacturers
Worked with the manufacturer on system requirements, design, and chemical safety aspects

OTHER EQUIPMENT **2004-2008**
Following is a brief description of some other equipment that was researched and purchased by me.
Nanonex NX-B200 Nano-Imprinter
Disco DAD3220 Automatic Dicing Saw, 160mm
AJA ATC ORION SERIES UHV SPUTTERING SYSTEM
AJA ATC ORION SERIES EVAPORATION SYSTEM
AJA ATC ORION SERIES THERMAL EVAPORATION SYSTEM
LSM 5 Pascal Confocal Microscope
TYTAN Mini 3600 Three Stack Horizontal Furnace System

Ocean Optics Inc., NanoCalc UV-VIS Reflectometry System:
Reflectometer for thin film thickness measurement from 10 nm to 20 micron with wavelength range of 200 nm to 850 nm
Four-point Probe System :
JANDEL ENGINEERING LTD, Model MWP-6-SPEC probe stand, and RM3 Test unit
-Measures resistivity/sheet resistance of wafers and thin films
Optical Backside Contact Mask Aligner
Optical Associates Inc. (OAI), Model: 806 MBA
Electrical Test System
-Agilent 4155C Semiconductor Parameter Analyzer and 4284A Precision LCR Meter
-Micromanipulator Model 8060-US8-V0-1-A probe station with light-tight enclosure and 8” triaxial chuck
Surface Profiler
AlphaStep IQ
-Measures thickness from 5 nm to 40 micron
Rapid Thermal Processor
JetFirst 150
PlasmaQuest Model 129 Sputter System Three rotating-magnetron sputter guns of 4" diameter, three Advanced Energy's MDX magnetron drives (dc power sources), 8" variable temperature chuck with rotating substrate, RF-biased chuck for in-situ substrate cleaning, transfer chamber with automatic substrate loading/unloading, computerized operation. Upgrade: One RF power supply (300 W) and matching network. This equipment was a donation.
PlasmaQuest Model 128 ECR (electron cyclotron resonance) plasma system Plasma Injection Source(MECR), Microwave generator 2.45GHz, 1500 Watt (ASTeX, mode AX2115, transfer chamber with automatic substrate loading/unloading, RF-biased chuck for vertical wall etching and in-situ substrate cleaning (1000 watt RF generator). This equipment was a donation.

Post-doctoral Work (1999-2002)

Projects

Silicon Resonant Tunneling Diode: Resonant tunneling diodes provide very high speed that can be utilized for analog applications such as THz frequency oscillators. The negative resistance region of the I-V curve can be used for digital applications such as record low-power tunneling SRAMs. We are working on developing $SiO_2/Si/SiO_2$ RTDs in MBE system.
Lattice-matched Insulators on Silicon: This technology, if developed, would lead to unique three-dimensional stacking of devices and to ultra-thin gate insulators. Epitaxial growth of beryllium chalcogenides using MBE is being investigated for this purpose. Another application of this technology is Si/BeSeTe/Si quantum well structure considering BeSeTe as wide bandgap semiconductor. This multi-quantum well structure is suited for efficient solar cells.

Project Management

Management: This included project scheduling, need analysis, equipment identification, specification analysis, and equipment requisition, equipment setup and maintenance, and process development.
Supervision: Supervised five or more trained graduate and undergraduate student employees on a regular basis.
Training: Trained graduate and undergraduate students on clean room equipment use and maintenance.

Electrical Characterization

Test equipment used: DLTS from Sula Technologies, HP4284A Precision LCR Meter, HP4275A LCR Meter, HP4276A LCZ Meter, HP4140B pA Meter/DC Voltage Source.
Deep Level Transient Spectroscopy: Interface trap studies of advanced gate dielectrics on Si were done by DLTS and constant capacitance DLTS. The results were compared with those from C-V measurements. The

test equipment used was from Sula Technologies that consisted of pulse generator, capacitance meter, and correlator. Pulse generator provided pulses to the sample. Capacitance meter, based on self-balancing bridge circuit, measured the small and rapid changes in the capacitance. The correlator was based on a double boxcar signal averaging technique. It removed the dc background from the capacitance meter output and amplified the resultant signal change.
I-V/C-V Characterization: These were done for silicon resonant tunneling diodes and, lattice-matched and amorphous dielectrics on Si using the automated system. The probe station was enclosed in a black box. Current values as low as a few pA and capacitance as small as a few pF, could be measured with this system.

Material Characterization

X-ray: XRD rocking curve analyses of MBE grown heterostructures were extensively used. Theta-2 theta and glancing angle measurements were utilized too. Lang measurements were done on the whole wafer to see the spatial variations in structural defects in the epitaxial films.
Ellipsometry: Rotating analyzer ellipsometer was utilized to measure the thickness and refractive index of the films optically.
n&k: Thin films were also measured using n&k Technology's n&k Analyzer. This new type of equipment consists of proprietary software and a spectrometer. The following quantities can be measured for thin films with this equipment: thickness, refractive index, extinction coefficient (k), energy bandgap, and interface roughness. Since these quantities are calculated just from reflectance spectrum (R) in the wavelength range 190 – 900 nm without using the phase shift, no analyzers and polarizers are needed.
Photoluminescence & photo-current: These are being setup for characterization of BeSeTe/Si heterostructures.

Atomic Force Microscopy

Surface Topography: Sub-angstrom level surface roughness studies of lenses and prisms were done. Submicron high aspect ratio structures, for example gratings for surface emitting lasers, were measured too.
Novel Uses: Nano-oxidation. Modification of AFM for I-V/C-V measurement of nanostructures.

Computer

Automation: Computer automation for I-V/C-V measurement setup was done using GPIB (HPIB) interface with LabVIEW and HP-VEE software.
Applications: Origin, Mathematica, MS Office.

Doctoral Work (1993-1998)

Ferroelectric FET

Design: Ferroelectric FET was designed with the new structure that incorporates a thin MgO buffer layer between a ferroelectric PZT layer and an oxidized silicon substrate. The idea of using this two-layer buffer structure was based on the following reasons: First, it was found that PZT films could be grown highly oriented on MgO-buffered oxidized silicon substrates, Second, MgO has been widely used as a diffusion barrier for various material systems because of its refractory nature.

Regarding the structural issue, reducing the buffer layers' thickness is expected to decrease the operating voltage because the voltage drop across each layer is inversely proportional to the capacitance of the layer. Regarding the materials issue, it is desirable to tailor the ferroelectric properties of PZT films such that they show a significantly reduced dielectric constant and maintain a large coercive voltage even at much reduced film thickness.
Fabrication: Process parameters were controlled to optimize all the fabrication steps. Masks were designed and made to have four different pattern sizes of devices on a single mask. The devices were fabricated with buffer layers' thickness as small as 10 nm and PZT thickness as small as 300 nm.
Testing: Testing methodology was developed to characterize the ferroelectric FETs. It starts with I-V scans and ends at real time pulse environment of memory devices. With the optimization of structure, materials,

and processes, a memory window of 1 Volt could be achieved for ±3 Volt writing voltage. Also, excellent retention capability and fatigue resistance was measured.

Thin Film Fabrication by RF Sputtering

PZT: A low thermal budget process was developed for the deposition of $Pb(Zr,Ti)O_3$ films. It comprised low substrate temperature deposition using a stoichiometric target and short time conventional furnace annealing. High quality (100) oriented PZT films were obtained by this process. A $PZT/ZrTiO_4$ heterostructure was also grown from a single stoichiometric PZT target with a two-step single-deposition process. Loss of lead during high substrate temperature deposition was utilized to develop this process.

Platinum: Sputtering parameters were controlled to get highly (111) oriented platinum films on oxidized silicon with good adhesion.

Magnesium Oxide: High quality (100) oriented MgO films were obtained on oxidized silicon by reactive sputtering. For this deposition, pure magnesium target was used in argon/oxygen ambient.

Silicon Nitride: SiN films showed dielectric constant and refractive index values very close to the bulk values. These films were obtained by optimizing reactive sputtering using a silicon target.

Microelectronic Fabrication

Photolithography: It was extensively used for pattern definition. Minimum dimensions of 5μm could reliably be obtained with our system. Photolithography techniques were developed to suit the following processes of etching and lift-off. Masks were designed and made in our labs.

Plasma Etching: Plasma etching was utilized to etch SiN and SiO_2 for device fabrication.

Chemical Etching: Standard chemical etchants were prepared and modified to suit our conditions. Using these chemicals several types of materials were etched for example, MgO thin films, SiO_2, and silicon (anisotropic etching).

Lift-off: This process was optimized for the materials for which plasma and chemical etching did not work for example, PZT. It also proved very useful when the damage caused by the etching at the pattern edges was harmful to the device operation for example, for integrated waveguides.

Thermal and Electron Beam Evaporation: Thermal and electron beam evaporations were utilized for metal depositions.

Diffusion: Diffusions were done extensively for making pn junctions, MOSFETs, and ferroelectric field effect transistors. Solid sources were used for diffusions in a furnace.

Other Processes: Oxidation (both wet and dry), wire bonding, annealing and other fabrication steps were done routinely.

Electrical Characterization

This was done using modern probe station and test fixtures. HP4145B Semiconductor Parameter Analyzer and Keithly C-V Analyzer equipped with programmable voltage and current sources, voltmeter, and current meter were used.

Resistivity and Dielectric Constant Measurements: These were done as a quick check of materials' quality.

I-V Measurement: I-V scans were done for materials as well as for devices. These were very useful to observe the nonlinear behavior of the materials and to compare the films processed or deposited under different conditions. These were also used for studying the strength and breakdown phenomena of the materials. In the case of devices, I-V scans were done on ohmic contacts, pn junctions, MOSFETs, ferroelectric field effect transistors, and silicon resonant tunneling diodes. Special setups were used to characterize MOSFETs and ferroelectric FETs.

C-V Measurement: C-V scans were done to check for nonlinear behavior of the materials and the devices. On materials these tests were done to check and compare the ferroelectric films. These also helped understand many device phenomena.

Tests for Ferroelectric Films: In addition to C-V measurement, a modified Sawyer-Tower circuit was designed to do ferroelectric hysteresis measurements. Fatigue measurements were also done to study the causes of ferroelectric fatigue.

Sheet Resistivity: Sheet resistivity measurements were done on the diffused films by four-point probe method. These were done to optimize the diffusions in silicon.

Material Characterization

Thickness Measurement: Thickness of the films and of the other patterned structures was measured by Tencor's Alpha Step, an automated thickness measuring instrument that uses stylus approach.

Surface Analysis: Nomarski phase contrast optical microscope was extensively used for studying the surface features. For larger magnification and for cross-section studies scanning electron microscope (SEM) was used.

Structure Analysis: Philips diffractometer was extensively used for X-ray diffraction. It was used as a first tool for structure analysis of materials.

Chemical Composition Analysis: The chemical composition of the PZT films, and of the cross-sections of PZT/MgO/SiO_2/Si and PZT/SiO_2/Si was studied by X-ray spectroscopy analysis in a Philips XL 30 scanning electron microscope (SEM) with a Schottky field emission source. This SEM was equipped with an EDAX solid state X-ray spectrometer (EDS) with an ultra-thin window detector.

Optical Characterization

Waveguides: Light was coupled in and out of waveguides, mounted on high-precision computer-controlled translation stages, using optical fibers. Proper fiber handling and polishing techniques were mastered for single-mode optical fibers. This work included working with gas, solid state, and semiconductor lasers, with wavelengths ranging from 633 nm to 1.5 μm, as well as polarization preserving optical fibers. Lens-tipped tapered single mode fibers were fabricated by etching and arc-melting, and were used to effectively couple the laser light in and out of the waveguides.

Dark-line spectroscopy: The refractive index and guided modes of different films were studied by coupling laser light into the film using a high refractive index prism.

Equipment Design and Maintenance

Design: Designed and built a high-vacuum sputtering system having two RF magnetron guns for the deposition of a large variety of thin films and heterostructures.

Automated Data Acquisition: Developed software in Turbo Pascal and Basic with accompanying hardware to control translation stages and to acquire data from optical sensors.

Maintenance: Maintained/repaired all the equipment used.

Computer Skills

Word Processing, Spreadsheets, and Plotting: Microsoft Word, Word Perfect, Excel, Axum, Origin.

Scientific Programs: Mathematica, Spice, AutoCAD, MathCAD, Magic (IC layout design).

Languages: C, FORTRAN, Turbo Pascal, BASIC, VHDL.

Computer Environments: Unix, VMS, X-Windows, Microsoft Windows 98 and NT, and DOS.

PUBLICATIONS AND PRESENTATIONS

Updated list is available upon request

THESIS AND DISSERTATION

Ph.D.: "A study of PZT films and ferroelectric field-effect transistors", Department of Electrical Engineering, University of Pittsburgh, 1998.

M.S.: "Study of Pb(Zr,Ti)O_3 films deposited on GaAs substrates by RF magnetron sputtering", Department of Electrical Engineering, University of Pittsburgh, 1992.

RESIDENCE STATUS

Naturalized citizen of USA