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Cornell NanoScale Facility 2021-2022 Research Accomplishments

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The 2021-2022 CNF Research Accomplishments are also available on the web in full color:
http://cnf.cornell.edu/publications/research_accomplishments

Table of Contents

Electronics, pages 50-65

Materials, pages 66-97

Mechanical Devices, pages 98-111

Optics & Opto-Electronics, pages 112-149

Optics, continued

Physics & Nano-Structure Physics, pages 150-181

Process & Characterization, pages 182-191

Index, pages 192-194

Directors' Welcome

The Cornell NanoScale Science & Technology Facility presents the 2021-2022 CNF Research Accomplishments!

*"**First steps are always the hardest** but until they are taken the notion of progress remains only a **notion** and not an achievement."*

*– **Aberjhani***

Gratitude and Continued Thanks

This year marks the 45th Anniversary of the Cornell Nanoscale Facility. Since 1977 CNF has been proudly recognized as a national and international facility dedicated to serving the needs of its diverse community of users and research groups. The extensive resources offered at the CNF, including an expansive collection of equipment capabilities and a staff dedicated to excellence have allowed the CNF to command a strong, influential presence in emerging, state-of-the-art nanotechnology research that is second to none. We remain thankful to the users for their contributions to this publication and for the trust they have placed in the CNF to help them successfully achieve results. We would also like to acknowledge all the companies, groups and people who have supported and contributed to the success of the CNF over the last 45 years, we could not have done it without you! Forty-five years is quite the milestone and we look forward to continuing to evolve and grow with the continued dedication and support of our diverse research community. You are all appreciated.

Progress and Commitment Through the Years

The CNF has grown tremendously since 1977 when Cornell won a national competition to become the first NSF funded, "microfabrication" user facility. Originally referred to as the National Research and Resource Facility for Submicron Structures (NRRFSS), the CNF evolved through six rounds of NSF facility funding. This transformation timeline includes the National Nanofab Facility (NNF) in 1987, The Cornell Nanofab Facility (CNF) in 1993, the Cornell Node of the National Nanotechnology Users Network (NNUN) in 1994, the National Nanotechnology Infrastructure Network (NNIN) in 2004, to its present membership in the National Nanotechnology Coordinated Infrastructure (NNCI) since September 2015. One thing that has remained constant during the CNF's history is its proven commitment to the advancement of science and technology through continued support of academic, industrial, and government research communities. CNF prides itself on its seasoned staff who work diligently to serve and address the needs of the user community. Their extensive expertise enables high equipment uptime, thorough training, and provision of valuable technical advice that is paramount to successful user outcomes.

What We Have Been Up To and Future Plans

The CNF is excited to continue its membership in the National Nanotechnology Coordinated Infrastructure (NNCI) with support provided by the National Science Foundation (NSF) and the NYSTAR/ESD Matching Grant Program from New York State. This support is critical to CNF and its position in the vanguard of the nanofabrication industry. Cornell is one of 16 sites working collaboratively as a national user consortium committed to providing cutting edge fabrication and characterization tools to users from industry

and academia. Earlier this year the CNF submitted "The Year 7 Annual Report" and participated in a successful, virtual, reverse site visit as part of the cooperative agreement with the NNCI.

In May the CNF hosted the first New York State Nanotechnology Network (NNN) symposium and workshop to identify initiatives aimed at bridging the workforce gap. The CNF is pleased to have assumed a leadership role in the establishment of the NNN. The overall mission of the NNN is to help build regional relationships, solve common problems, and grow awareness of the state's nanotechnology capabilities while providing more synergistic opportunities for workforce development within the state. The 2023 meeting will be hosted by SUNY Albany.

August presented the CNF with the opportunity to host the 2022 NNCI Nanoscale Internet-of-Things (Nano-IoT) Research Community Workshop. The meeting was hybrid allowing attendees to participate in-person or virtually via Zoom. The workshop assisted the NNCI network in planning the future of nanotechnology as well as the identification and exploration of goals for the Nano-IoT.

Considering CNF is midway through the second half of its grant period, it is crucial to begin planning the strategic focus of activities and equipment acquisitions for the next 5 -10 year period. Following the 2022 Annual Meeting key experts in nanotechnology will gather for an exclusive strategic planning workshop that will define the CNF's future strategic direction.

As we enter the final months of the year the CNF is thrilled to be hosting the 2022 National Nanotechnology Coordinated Infrastructure (NNCI) Annual Conference on October 19 -21st at Cornell University. In this closed meeting, we look forward to engaging in discussions, updates, and idea exchanges with the leadership of the other NNCI sites. It is sure to be a valuable, energizing in-person exchange!

Comments, feedback, and suggestions about CNF are always welcome. Feel free to use our online User Comment Form at https://www.cnfusers.cornell.edu/user_feedback

Warm Welcomes and Recent Additions

We are thrilled to extend a warm welcome to two, new Advanced Lithography Research Associates; Dr. Roberto Panepucci who began in June, and Dr. Giovanni Sartorello joined us in September. Their knowledge and expertise will further enhance the CNF and we look forward to their contributions.

Dr. Roberto Panepucci received his Master's (1990) and Bachelor's (1989) in Applied Physics from the University of São Paulo (USP), São Carlos, and his Ph.D. from the University of Illinois at Urbana-Champaign, Illinois in 1996. He was a postdoctoral fellow at the Device Research Laboratory at Unicamp, Brazil, working on III-V devices. Dr. Panepucci joined the Cornell Nanofabrication Facility (CNF) in 1999 as a Senior Researcher. He joined startup Galayor Networks in 2000 and led the MEMS R&D team in developing suspended waveguide silicon photonic devices. In 2002 he joined the Nanophotonics Group at Cornell where he led the nanofabrication of key novel silicon photonic devices in SOI technology. From 2003 to 2008 he was an Assistant Professor at FIU developing photonic devices in silicon and polymers and received tenure with promotion to Associate Professor at FIU in 2009. He took a leave of absence to join CTI, a national research center in Brazil, as a Senior Researcher where he served as General Coordinator and Deputy Director. Dr. Panepucci headed the Hardware Systems Design Division and coordinated projects in the area of photonic integrated circuits in silicon and the fabrication of micro and nano systems. He has been an associated researcher with the Brazilian Neuroscience and Neurotechnology Institute (BRAINN) since 2013, coordinating research in neural probes and micro-electrode arrays. He was vice-coordinator of the CTINano, of the Strategic Laboratories of the Brazilian initiative in Nanotechnology prior to joining CNF as Research Associate.

Dr. Giovanni Sartorello, obtained his BSc and MSc in Physics from the University of Padua in Italy, graduating in 2013. He studied for his PhD at King's College London in the UK, where he worked on light-controllable plasmonic meta surfaces in Anatoly Zayats's group. He graduated in 2018 and moved to Cornell in 2019, where he worked in Gennady Shvets's group on the control of nonlinear generation with dielectric meta surfaces. Part of his work as a CNF user has focused mainly on

meta surface fabrication via Ebeam lithography (EBL), chromium or resist masks, and reactive-ion etching. He's also conducted extensive metrology and microscopy and has hands on photolithography experience.

In November of 2021 we welcomed James Crawford to the CNF family after previously working at Ithaca College. James has already established himself as a key staff member responsible for maintaining CNF mechanical facilities, process gas supplies, and research equipment critical to lab operation.

Outreach and Recognition

2022 marked the return to in-person learning for CNF's short course, "Technology and Characterization at the Nanoscale (TCN)" as well as education and community outreach events. Given the success of the virtual TCN short course, CNF will be offering the course virtually each January and in- person each June. By continuing this important educational initiative, the CNF will be able to reach an even more expansive audience. The course is open to participants from academia, industry and government and will include lectures and key demonstrations of the concepts involved in micro and nanoscale device fabrication. The most recently held TCN course opened with daily guest lectures from CNF investigators that aligned with the day's educational content. The guest presenters were very well received and will be a permanent part of our TCN program.

The education and outreach program also had a very successful year with CNF hosting nearly 400 students for tours and activities at our facility in Duffield Hall. The largest event was the Tompkins County Expanding Your Horizons Conference that welcomed over 200 budding, young scientists to the facility to explore nanoscience and watch a live, virtual tour of the cleanroom. In addition, the CNF continues to maintain a partnership with the 4-H Club, through participation in their multi-day Career Explorations event each June.

In recognition of our 45th anniversary celebration the CNF worked with the ScienCenter to bring the Nano Mini-Exhibition to Ithaca. As part of this collaboration, Tom Pennell worked to expand the exhibit by including content on plasma and biomimetics. Tom was instrumental in planning and building an interactive plasma globe exhibit for visitors to enjoy and installing a Nanooze magazine rack that provided distribution of several hundred issues to the local community.

The Education and Outreach program is always working to develop new and exciting educational content to spark greater interest in the field of science. To discuss how your research might translate into a fun, educational experience or to schedule an outreach event, please contact Tom Pennell (pennell@cnf.cornell.edu).

NNCI Awards

Congratulations to Melanie-Claire Mallison and Aaron Windsor who were recently honored with national awards from the NNCI. Annually, the NNCI acknowledges the efforts of NNCI staff who provide exceptional service and support to network users in the categories of Technical Staff, Education and Outreach, and User Support. This year Aaron was a recipient of the NNCI Staff Award in the User Support category and Melanie-Claire was granted the NNCI Staff Award for Education and Outreach. Melanie-Claire and Aaron will receive a plaque and acknowledgement at the NNCI Annual Conference. The exceptional staff at the CNF have been consistently recognized with NNCI Outstanding Staff Member Awards. Past award recipients include Chris Alpha – Technical Staff (2018), Tom Pennell – Education and Outreach (2020), Phil infante – Technical staff (2021) and Mike Skvarla – User Support (2021).

Reflecting on the history of the CNF and where it stands today, we are proud of our achievements and look forward future progress. Thank you for being a part of the CNF's success over the past four and a half decades. We greatly appreciate and value everyone who has contributed to the continued growth and success of the Cornell NanoScale Science & Technology Facility. The dedication and commitment you have all demonstrated was integral in making the CNF what it is today, a leader in the national and international nanoscale communities. Happy 45th Anniversary!

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A Selection of 2021 CNF-Research-Related Patents, Presentations, and Publications

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Common Abbreviations & Meanings

µl. . . . . microliter
µm. . . . . micron, micrometer
µN. . . . . micro-Newtons
µs . . . . . microsecond
Ω. . . . . Ohm
<. . . . . is less than
>. . . . . is greater than
~. . . . . approximately
1D. . . . . one-dimensional
2D. . . . . two-dimensional
2DEG. . . . . two-dimensional electron gas
3D. . . . . three-dimensional
^{3}He helium-3
a-Al_2O_3. . . . . sapphire
a-Si . . . . . amorphous silicon
AC. . . . . alternating current
AFM. . . . . atomic force microscopy/microscope
AFOSR. . . . . Air Force Office of Scientific Research
Ag. . . . . silver
Al . . . . . aluminum
Al_2O_3 . . . . . aluminum oxide
ALD. . . . . atomic layer deposition
AlGaAs. . . . . aluminum gallium arsenide
AlGaN. . . . . aluminum gallium nitride
Ar . . . . . argon
ARC. . . . . anti-reflective coating
ArF . . . . . argon fluoride
As . . . . . arsenic
atm . . . . . standard atmosphere (as a unit of pressure)
Au. . . . . gold
AuNPs . . . . . gold nanoparticles
B. . . . . boron
B. subtilis. . . . . *Bacillus subtilis*
Bi . . . . . bismuth
BOE. . . . . buffered oxide etch
Br . . . . . bromine
C. . . . . carbon
C. . . . . centigrade
C-V. . . . . capacitance-voltage
C_3N_4. . . . . carbon nitride
$CaCl_2$ . . . . . calcium chloride
$CaCO_3$. . . . . calcium carbonate
CAD. . . . . computer-aided design
CaF_2. . . . . calcium fluoride
CCMR. . . . . Cornell Center for Materials Research
Cd. . . . . cadmium
CdS . . . . . cadmium sulfide
CdSe. . . . . cadmium selenide
CDW . . . . . charge-density-wave
Ce . . . . . cerium
CF_4. . . . . carbon tetrafluoride or tetrafluoromethane
CFD. . . . . computational fluid dynamics
CH_4 . . . . . methane
CHESS . . . . . Cornell High Energy Synchrotron Source
CHF_3. . . . . trifluoromethane
Cl. . . . . chlorine
Cl_2. . . . . chlorine gas
Cl_2/SF_6. . . . . chlorine sulfur hexafluoride
cm. . . . . centimeter
CMOS. . . . . complementary metal oxide semiconductor
CMP. . . . . chemical mechanical polishing
CNF. . . . . Cornell NanoScale Science & Technology Facility
Co. . . . . cobalt
CO_2 . . . . . carbon dioxide
Co_3O_4. . . . . cobalt oxide
CoFeAl. . . . . cobalt iron aluminum
CoFeB. . . . . cobalt iron boron
CoP . . . . . cobalt porphyrin
CPC. . . . . colloidal photonic crystal
CPD. . . . . contact potential difference
CpG. . . . . cytosine-phosphate-guanine
Cr . . . . . chromium
CRDS. . . . . cavity ring-down spectrometer
cryoSAXS . . . . cryogenic small angle x-ray scattering
CTE. . . . . coefficients of thermal expansion
CTL. . . . . confinement tuning layer
Cu. . . . . copper
CVD. . . . . cardiovascular disease
CVD. . . . . chemical vapor deposition
CW . . . . . continuous wave
CXRF. . . . . confocal x-ray fluorescence microscopy
DARPA. . . . . Defense Advanced Research Projects Agency
DC. . . . . direct current
DCB. . . . . double cantilever beam
DCE. 1,2-dichloroethane
DCM. . . . . dichloromethane
DEP. . . . . dielectrophoresis
DFT. . . . . density functional theory
DFT. . . . . discrete Fourier transform
DI . . . . . de-ionized
DMF. . . . . dimethyl formamide
DNA. . . . . deoxyribonucleic acid
DNP. . . . . dynamic nuclear polarization
DOE. . . . . United States Department of Energy
DPPC. 1,2-dipalmatoyl-sn-glycero-3-phosphocholine
DRAM. . . . . dynamic random access memory
DRIE . . . . . deep reactive ion etch
DSA. . . . . directed self assembly
dsDNA . . . . . double-stranded DNA
DUV. . . . . deep ultraviolet
e-beam . . . . . electron beam lithography
E. coli. . . . . *Escherichia coli*
EBL. . . . . electron-beam lithography
EDS. . . . . energy dispersive spectroscopy
EELS . . . . . electron energy loss spectroscopy
EG. . . . . ethylene glycol
EIS. . . . . electrochemical impedance spectroscopy
ELISA. . . . . enzyme-linked immunosorbent assays
EO. . . . . electro-optic
EOT. . . . . equivalent oxide thickness
EPICs. . . . . electronic photonic integrated circuits
Er . . . . . erbium
ErAs. . . . . erbium arsenide
ESM. . . . . effective screening medium
EUV. . . . . extreme ultraviolet
ex situ. . . . . Latin phrase which translated literally as 'off-site' -- to examine the phenomenon in another setting than where it naturally occurs
ex vivo . . . . . Latin for "out of the living" -- that which takes place outside an organism
F. . . . . fluorine
FDA. . . . . United States Food & Drug Administration
FDMA. . . . . fluorinated perfluorodecyl methacrylate
Fe . . . . . iron
Fe_2O_3 . . . . . iron oxide
$FeCl_3$ . . . . . iron(III) chloride, aka ferric chloride
FeGe. . . . . iron germanium
FEM. . . . . finite element method
FET . . . . . field-effect transistor
FFTs. . . . . fast Fourier transforms
fg. . . . . femto gram
FIB. . . . . focused ion beam
FIR . . . . . far infrared
fJ. . . . . femto Joules
FM. . . . . frequency modulation
FMR. . . . . ferromagnetic resonance
FOTS . . . . . fluorosilane, tridecafluoro-1,1,2,2-tetrahydrooctyltrichlorosilane

FTIR. . . . . Fourier transform infrared spectroscopy
Ga . . . . . gallium
Ga_2O_3 . . . . . gallium(III) trioxide
GaAs . . . . . gallium arsenide
GaAsN . . . . . gallium arsenide nitride
GaInNAs. . . . . gallium indium nitride arsenide
GaN . . . . . gallium nitride
GaP . . . . . gallium phosphide
GaSb . . . . . gallium antimonide
Gd. . . . . gadolinium
Ge . . . . . germanium
GFET . . . . . graphene field effect transistor
GHz. . . . . gigahertz
GI . . . . . gastrointestinal
GMR. . . . . giant magnetoresistance
GPa . . . . . gigapascal
GPS . . . . . global positioning system
h. . . . . hours
H . . . . . hydrogen
H_2O_2. . . . . hydrogen peroxide
HBAR. . . . . high-overtone bulk acoustic resonator
hBN. . . . . hexagonal boron nitride
HBr . . . . . hydrogen bromide
hcp . . . . . hexagonal close packing
He. . . . . helium
HEMTs. . . . . high electron mobility transistors
Hf . . . . . hafnium
HF. . . . . hydrofluoric acid
HfB_2 . . . . . hafnium diboride
HFEs . . . . . hydrofluoroethers
HfO_2 . . . . . hafnium dioxide
Hg. . . . . mercury
high-k. . . . . high dielectric constant
HMDS. . . . . hexamethyldisilazane
HRS. . . . . high resistance state
HSQ. . . . . hydrogen silsesquioxane
HSQ/FOx. . . . negative electron beam resist hydrogen silsesquioxane
Hz. . . . . Hertz
I-V. . . . . current-voltage
I/O. . . . . input/output
IARPA. . . . . Intelligence Advanced Research Projects Activity
IC . . . . . integrated circuit
ICP. . . . . inductively coupled plasma
ICP-MS. . . . . inductively coupled plasma mass spectroscopy
ICP-RIE. . . . . inductively coupled plasma reactive ion etcher
IFVD . . . . . impurity free vacancy diffusion
IID . . . . . impurity induced disordering
IIEI . . . . . ion implant enhanced interdiffusion
In . . . . . indium
in situ . . . . . Latin phrase which translated literally as 'in position' -- to examine the phenomenon exactly in place where it occurs
in vitro . . . . . Latin for "within glass" -- refers to studies in experimental biology that are conducted using components of an organism that have been isolated from their usual biological context in order to permit a more detailed or more convenient analysis than can be done with whole organisms
in vivo. . . . . Latin for "within the living" -- experimentation using a whole, living organism
InAlN. . . . . indium aluminum nitride
InAs . . . . . indium arsenide
InAs NWs . . . . indium arsenide nanowires
INDEX . . . . . Institute for Nanoelectronics Discovery and Exploration
InGaAsN. . . . . indium gallium arsenide nitride
$InGaZnO_4$ . . . indium gallium zinc oxide
InP. . . . . indium phosphide
IPA. . . . . isopropyl alcohol
IR . . . . . infrared
IrO_2 or IrO_x . . iridium oxide
ITO . . . . . indium tin oxide
JP-8 . . . . . Jet Propellant 8
k. . . . . dielectric constant
K. . . . . Kelvin (a unit of measurement for temperature)
K. . . . . potassium
KFM . . . . . Kelvin force microscopy
kg . . . . . kilogram
kHz . . . . . kilohertz
KOH . . . . . potassium hydroxide
La . . . . . lanthanum
LED . . . . . light-emitting diode
LER . . . . . line edge roughness
Li. . . . . lithium
low-k. . . . . low dielectric constant
LPCVD . . . . . low pressure chemical vapor deposition
lpm . . . . . liter per minute
LRS . . . . . low resistance state
Lu . . . . . lutetium
LWR. . . . . line width roughness
MBE. . . . . molecular beam epitaxy
MEMs. . . . . microelectromechanical systems
MFMR . . . . . microfabricated micro-reactors
MgO . . . . . magnesium oxide
MGs. . . . . molecular glasses
MHz. . . . . megahertz
micron. . . . . micrometer, aka μm
min . . . . . minutes
ml . . . . . milliliter
mm . . . . . millimeter
mM . . . . . millimolar
Mo . . . . . molybdenum
MOCVD. . . . . metal oxide chemical vapor deposition
MOS . . . . . metal oxide semiconductor
MoS_2 . . . . . molybdenum disulfide
$MoSe_2$. . . . . molybdenum diselenide
MOSFET. . . . . metal oxide semiconductor field effect transistor
MRAM . . . . . magnetic random access memory
MRFM . . . . . magnetic resonance force microscopy
MRI . . . . . magnetic resonance imaging
ms. . . . . millisecond
MSM . . . . . metal-semiconductor-metal
mTorr. . . . . millitorr
mV. . . . . millivolt
MVD. . . . . molecular vapor deposition
MΩ . . . . . megaohms
N . . . . . nitrogen
N_2 . . . . . nitrous oxide
nA. . . . . nanoAmperes
NaCl. . . . . sodium chloride
NASA . . . . . National Aeronautics & Space Administration
Nb. . . . . niobium
Nb_3Sn . . . . . triniobium-tin
NCs . . . . . nanocrystals
Nd. . . . . neodymium
NEMs. . . . . nanoelectromechanical systems
NH_4F . . . . . ammonium fluoride
Ni . . . . . nickel
NIH . . . . . National Institutes of Health
NIR . . . . . near-infrared
nL . . . . . nanoliter
nm. . . . . nanometer
NMP. n-methyl-2-pyrrolidone
NNCI . . . . . National Nanotechnology Coordinated Infrastructure
NPs . . . . . nanoparticles
NPs . . . . . nanopores
ns . . . . . nanosecond
NSF . . . . . National Science Foundation
NV . . . . . nitrogen-vacancy
NVM. . . . . non-volatile memory
NW FETs. . . . . nanowire field-effect transistors
O . . . . . oxygen
O_3 . . . . . trioxygen
OFET . . . . . organic field effect transistor
OLED. . . . . organic light-emitting diode

ONO . . . . . oxide/nitride/oxide
ONR-MURI . . Office of Naval Research Multidisciplinary University Research Initiative
OPV. . . . . organic photovoltaic cells
OTFT . . . . . organic thin-film transistor
Pa . . . . . Pascals
PAB . . . . . post-apply bake
PaC . . . . . Parylene-C
PAG . . . . . photoacid generator
Pb . . . . . lead
PBG. . . . . photonic bandgap
PbS . . . . . lead sulfide
PBS . . . . . phosphate-buffered saline
PbSe. . . . . lead selenide
PC. . . . . persistent current
PC. . . . . photocurrent
PCN. . . . . photonic crystal nanocavity
Pd . . . . . palladium
PD. . . . . photodetector
PDMS . . . . . polydimethylsiloxane
PEB . . . . . post-exposure bake
PEC . . . . . photoelectrochemical
PECVD . . . . . plasma enhanced chemical vapor deposition
PEDOT:PSS . . poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate)
PEG . . . . . polyethylene glycol
PEI. . . . . polyethyleneimine
pFET . . . . . p-channel field-effect transistor
PFM . . . . . piezo-response force microscopy
PGMA. . . . . poly(glycidyl methacrylate)
pH. . . . . a measure of the activity of hydrogen ions (H+) in a solution and, therefore, its acidity
Ph.D. . . . . doctorate of philosophy
PhC . . . . . photonic crystal
PL. . . . . photoluminescence
pL . . . . . picoliter
PLD . . . . . pulsed laser deposition
PMMA . . . . . poly(methyl methacrylate)
poly-Si . . . . . polycrystalline silicon
PS . . . . . polystyrene
PS-*b*-PMMA . . polystyrene-*block*-poly(methyl methacrylate)
Pt . . . . . platinum
Pt/Ir . . . . . platinum/iridium
$PtSe_2$ . . . . . platinum diselenide
PV. . . . . photovoltaic
PVD. . . . . physical vapor deposition
Py . . . . . permalloy, $Ni_{81}Fe_{19}$
Q. . . . . quality factor
QD . . . . . quantum dots
QW . . . . . quantum well
RA. . . . . resistance-area
REU. . . . . Research Experiences for Undergraduates Program
RF. . . . . radio frequency
RF MEMS . . . . radio frequency microelectromechanical systems
RIE . . . . . reactive ion etch
RMS or rms. . root mean square
RNA . . . . . ribonucleic acid
RTA . . . . . rapid thermal anneal
RTD. . . . . resistance temperature device
RTD. . . . . resonant tunneling diodes
Ru. . . . . ruthenium
s . . . . . seconds
S. . . . . sulfur
SAMs . . . . . self-assembled monolayers
SAXS . . . . . small angle x-ray scattering
Sb . . . . . antimony
Sc . . . . . scandium
sccm . . . . . standard cubic centimeters per minute
$scCO_2$ . . . . . supercritical carbon dioxide
SDS . . . . . sodium dodecyl sulfate
Se . . . . . selenium
sec . . . . . seconds
SEM. . . . . scanning electron microscopy/microscope
SERS . . . . . surface enhanced Raman spectroscopy
SF_6 . . . . . sulfur hexafluoride
Si. . . . . silicon
Si_3N_4. . . . . silicon nitride
SiC . . . . . silicon carbide
SiH_4 . . . . . silane
SiN. . . . . silicon nitride
SiO_2 . . . . . silicon dioxide, silica
Sn . . . . . tin
SnO_2. . . . . tin oxide
$SnSe_2$ . . . . . tin selenide or stannous selenide
SOI. . . . . silicon-on-insulator
SPR . . . . . surface plasmon resonance
SQUID . . . . . superconducting quantum interference device
Sr_2RuO_4. . . . . strontium ruthenate
SRC . . . . . Semiconductor Research Corporation
$SrTiO_3$ . . . . . strontium titanate
STEM. . . . . scanning transmission electron microscopy/microscope
t-BOC. . . . . *tert*-butoxycarbonyl
Ta . . . . . tantalum
Ta_2O_5 . . . . . tantalum pentoxide
TaN . . . . . tantalum nitride
TAO_x. . . . . tantalum oxide
Te . . . . . tellurium
TEM . . . . . transmission electron microscopy/microscope
TFET . . . . . tunnel field effect transistor
TFT . . . . . thin-film transistor
Tg . . . . . glass transition temperature
THz . . . . . terahertz
Ti . . . . . titanium
TiN . . . . . titanium nitride
TiO_2. . . . . titanium dioxide
TM. . . . . transverse magnetic
TXM . . . . . transmission x-ray microscopy
UHV . . . . . ultra-high vacuum
USDA. . . . . United States Department of Agriculture
UV. . . . . ultraviolet
UV-Vis . . . . . ultraviolet-visible
V. . . . . vanadium
V. . . . . voltage
vdW . . . . . van der Waals
VLS . . . . . vapor-liquid-solid
VRMs. . . . . voltage regulator modules
VSM. . . . . vibrating sample magnetometry
W . . . . . tungsten
WDM. . . . . wavelength-division multiplexing
WSe_2 . . . . . tungsten diselenide
XeF_2. . . . . xenon difluoride
XPM . . . . . cross-phase modulation
XPS . . . . . x-ray photoelectron spectroscopy
XRD. . . . . x-ray diffraction
XRR. . . . . x-ray reflectivity
ZMW . . . . . zero-mode waveguide
Zn . . . . . zinc
$ZnCl_2$ . . . . . zinc chloride
ZnO . . . . . zinc oxide
ZnO:Al . . . . . zinc aluminum oxide
ZnS . . . . . zinc sulfide or zinc-blende
Zr . . . . . zirconium
ZrO_2 . . . . . zirconium dioxide
ZTO. . . . . zinc tin oxide