



National Science Foundation

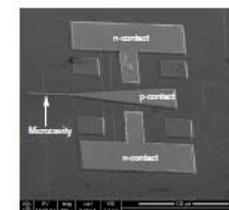
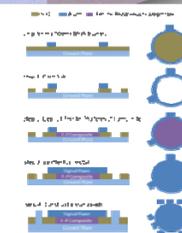
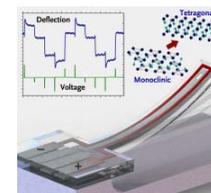
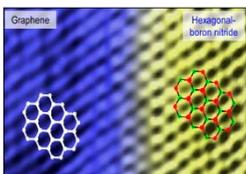
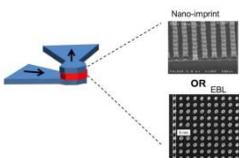
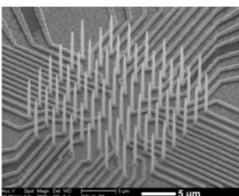
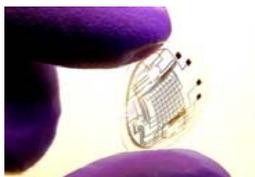
Electronics, Photonics, and Magnetic Devices (EPMD)

US-Ireland R&D Partnership Programme Workshop

September 29 - October 1, 2014

Dr. Dimitris Pavlidis
Program Director

Electrical, Communications and Cyber Systems Division





ECCS Mission

- Address fundamental research issues at the **nano, micro, and macro scales** underlying **device and component technologies, energy and power, controls, communications, computation, sensing and cyber systems**
- Support **integration of systems principles in complex engineering systems and networks** for a variety of applications domains
- Ensure **education of a diverse workforce** to meet the technological challenges of a 21st century global economy



Electronics, Photonics, and Magnetics Devices (EPMD) Program Goals

- Seeks to improve the fundamental understanding of devices and components based on the principles of microelectronics, optics and photonics, optoelectronics, magnetics, electromechanics, electromagnetics, and related physical phenomena.
- Enables discovery and innovation advancing the frontiers of nanoelectronics, spin electronics, molecular and organic electronics, bioelectronics, biomagnetics, non-silicon electronics, and flexible electronics.
- Emphasizes emerging areas of diagnostic, wearable and implantable devices and sensors, and supports manipulation and real-time measurement with nanoscale precision through new approaches to imaging and metrology.

Managed by

**Dr. Dimitris Pavlidis, Ms. Dominique Dagenais, Dr. Mahmoud Fallahi, Dr. Usha Varshney
(Vacant)**



Electronics, Photonics, and Magnetics Devices (EPMD)

Dr. Dimitris Pavlidis

- Microwave/mm-Wave/THz Devices & Components, and Electromagnetic Effects-based Components
- Nanoelectronics & Next Generation Devices, Semiconductor Material - Device Interaction and Reliability
- Widebandgap Semiconductors and Devices, Circuits, Device/Circuit Simulation & Modeling
- Metamaterial and Plasmonic-Based Devices & Components

Vacant

- Flexible, Printed and Organic Electronics & Photonics
- Carbon-based Electronics
- "Beyond" graphene 2D materials and devices
- Nano-electronics and Energy-Efficient electronics

Dr. Usha Varshney

- **Bioelectronics & Biomagnetics Devices**
- **Magnetics, Spin Electronics, Quantum Devices**
- **Sensor Device Technologies**
- **Next Generation Memories**

Dr. Mahmoud Fallahi & Ms. Dominique Dagenais

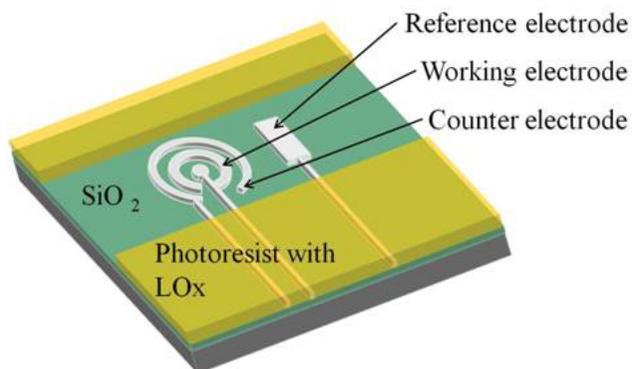
- Nanophotonics, Metamaterials & Plamonics
- Advanced Optical Sources & Photo-detectors
- Nonlinear & Ultrafast Photonics
- Photonics Integrated Circuits
- Optical Communication Components
- Single-photon and Quantum Devices
- Optical Imaging & Sensing
- Solar Cells & Photovoltaic Components



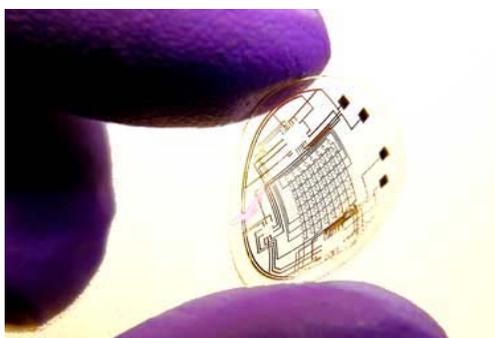
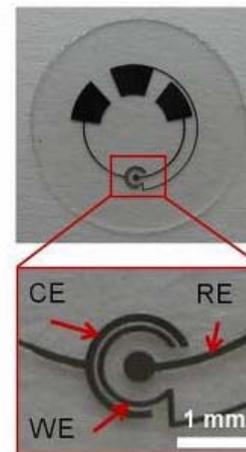
Dr. Usha Varshney



SGER-0533100, CAREER-0644084, EFRI-0937710 Babak Parviz, U. of Washington



Schematic of Sodium Lactate Sensor



First Contact Lens with an Integrated Lactate Sensor



Sensing Electrodes on Polyethylene Terephthalate (PET) Substrate

Biosensor utilizing Lactate Oxidase (LOx) Enzyme Immobilized on a Si/SiO₂ Substrate for the Detection of Sodium Lactate.

(Reported by MSNBC, Fox News, and Huffington Post)



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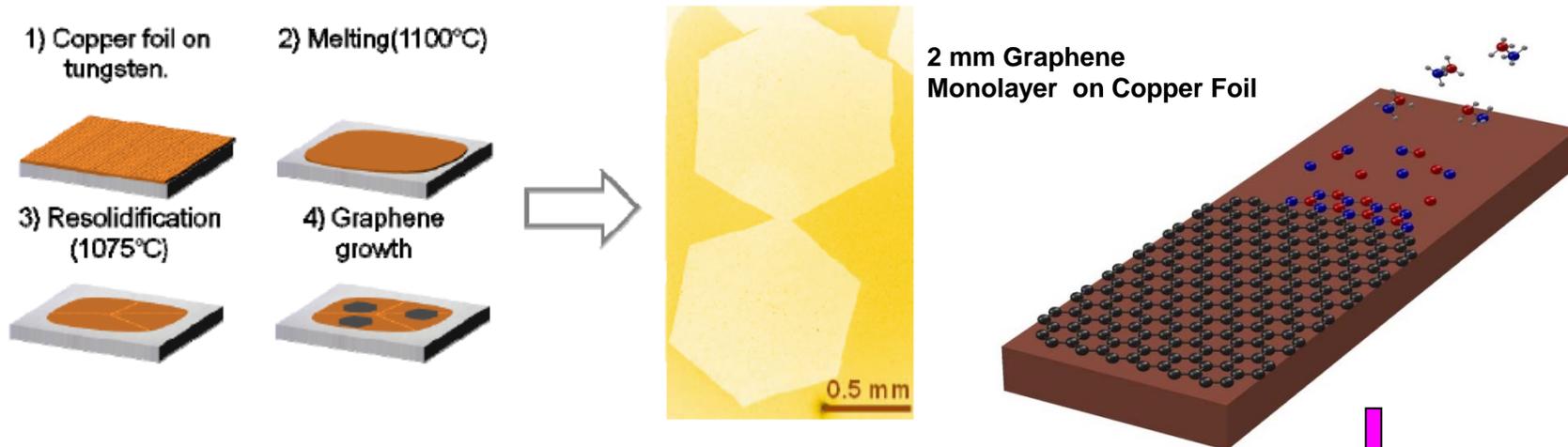
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(Dr. Anupama Kaul)

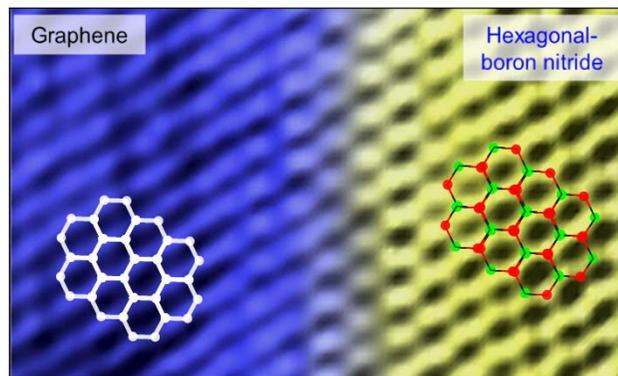


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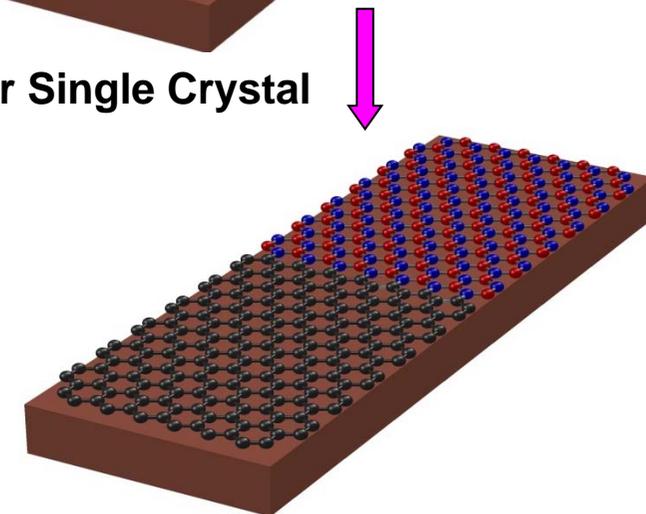
Gong Gu, U. of Tennessee



Schematic Synthesis Process and Graphene Monolayer Single Crystal



2D h-BN/Graphene Heterostructure



Novel Graphene-Insulator-Graphene Tunneling Junction Devices & Metal Oxide-Graphene-Silicon FET for High-Speed Electronics. (Science 2014)



Electronics, Photonics, and Magnetism Devices (EPMD)

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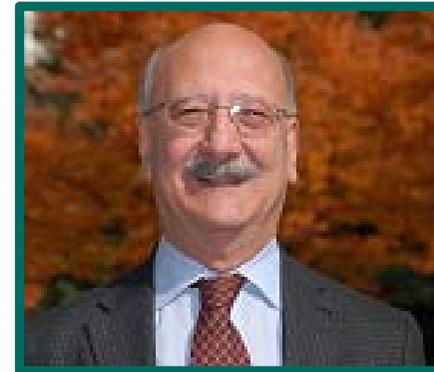
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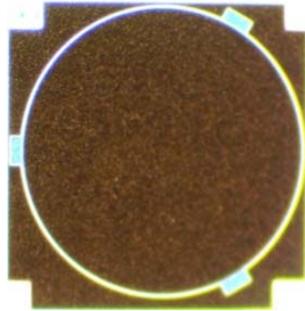


Dr. Dimitris Pavlidis



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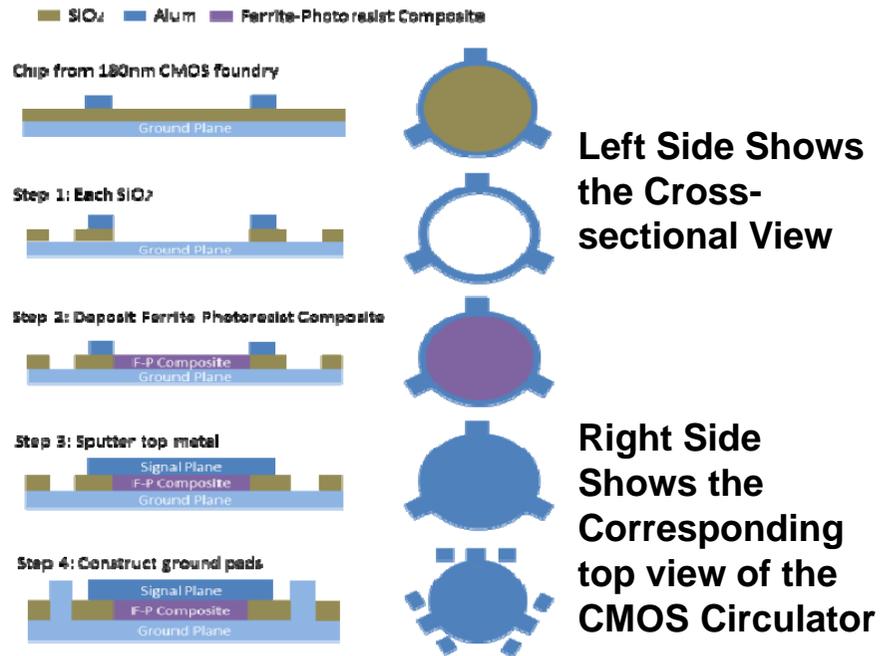
Mohammed Afsar, Tufts U. & DARPA



Microphotograph Top View of 1.4 mm Diameter Circulator Fabricated with a 180nm CMOS Process



Top View of Circulator Chip after Etching SiO₂ Operational in 10 GHz -100 GHz Range



Post-processing Steps to the Prototype Chip

Broadband Millimeter-Wave Barium and Strontium Hexagonal Nano-Ferrite Circulator Integrated in CMOS Technology (J of Appl. Phys. 2014)



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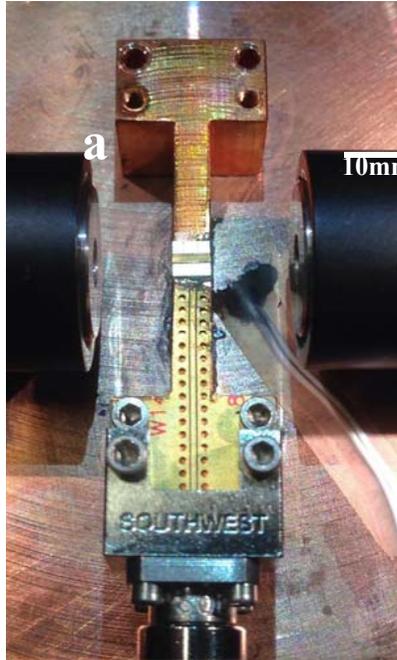
Dr. Mahmoud Fallahi



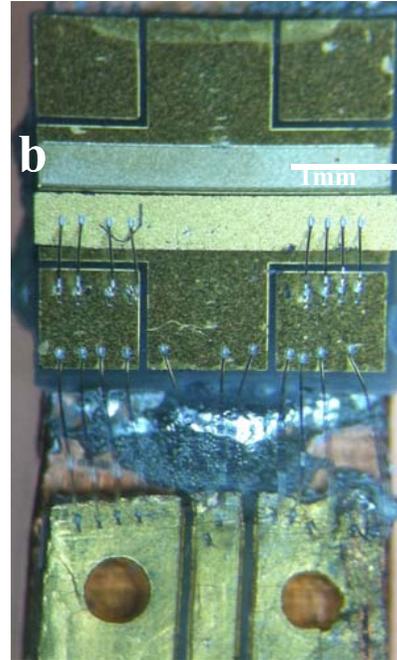
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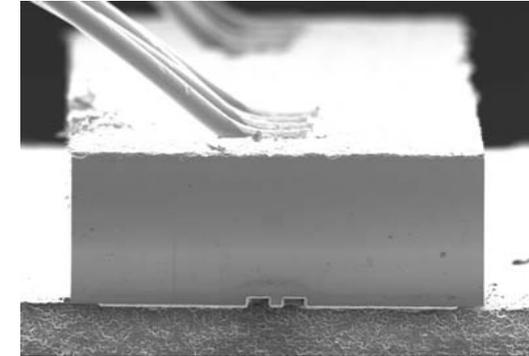
Collaborative: ECCS-1230517 / 1230477
Alexey Belyanin, Texas A&M U. & Federico Capasso, Harvard U.



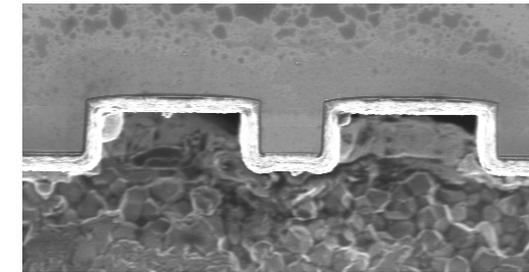
Laser Mounted to the end of a Microwave Strip-line



Short Wire-bonding Between QCL and Microwave Strip-line



Quantum Cascade Lasers (QCL) Mounted Epi-side down to an AlN Submount



View of the Facet

CW QCL Packaged for High-speed Modulation and Emission in a Ring Cavity for Generation of Picosecond Pulses. (Appl. Phys. Lett. 2013)



Centers

- **NSEC - Nanoscale Systems in Information Technologies**, Principal Investigator- Alexander Gaeta, Institution - **Cornell U., Brigham Young U., CCNY, Colgate U., Pomona College (Varshney)**
- **NERC - Nanosystems**, Principal Investigator- Greg Carmen, Institution - **UCLA (Kaul)**
- **ERC - Center for Intelligent Access Network (CIAN)**, Principal Investigator- Nasser Peyghambarian, Institution - **U. of Arizona, CalTech, Norfolk State U., Tuskegee U., the UC Berkeley, UCSan Diego, and UCLA, and USC (Dagenais)**
- **ERC - Mid-Infrared Technologies for Health and Environment (MIRTHE)**, Principal Investigator- Claire Gmachl, Institution – **Princeton (Pavlidis/Dagenais)**
- **ERC - Quantum Energy and Sustainable Solar Technologies (QESST)** Principal Investigator- Christiana Honsberg, Institution – **ASU (Pavlidis)**
- **Network for Computational Nanotechnology (NCN), NSF 12-504, (Cyber Platform, NanoBIO, NanoMFG and NEEDS) Nano-Engineered Electronic Device Simulation Node (NEEDS)** - Principal Investigator- Mark Lundstrom, Institution – **Purdue U. (Pavlidis)**



Initiatives and Foundation - wide Programs

- 2011-2013 ENG Emerging Frontiers in Research and Innovation (EFRI),
 - » Flexible Bioelectronics Systems (BioFlex), NSF 11-571 & NSF 12-583, (Varshney)
 - » Two-Dimensional Atomic-layer Research and Engineering (2-DARE) with AFOSR, NSF 13-583 (Kaul)
- Dear Colleague Letter - Optics and Photonics, NSF 14-091, ENG/MPS/CISE (Dagenais, Goldberg)
- ENG-MPS a joint initiative on Scalable Nanomanufacturing (SNM), NSF 12-544 (Kaul) & NSF 13-545 (Pavlidis)
- Dear Colleague Letter - Designing Materials to Revolutionize and Engineer our Future (DMREF), NSF 13-026 and NSF 14-027, (Pavlidis)
- WTEC Study (International) - 2D and 3D Composite Materials and Related Manufacturing Issues with ENG/MPS/CISE, AFOSR, NIST, and ONR (Initiated)
- MRI, GOALI, Brain Initiative & INSPIRE



Workshops

- **2010 NSF-ECCS Grantees' Conference**, in collaboration with the NSF-EPSCoR program, **Honolulu, HI**, for PIs in their 3rd and 4th years of research grants, to evaluate ECCS investments, U. of Hawaii system, Nov. 30-Dec. 3, 2010, **(Varshney)**
- **US-Russia Workshop on Emerging Trends in Bioelectronics**, June 27-29, 2011, **St. Petersburg, Russia**, **(Varshney)**
- **NSF (ENG, MPS) - AFOSR Workshop on 2D Materials and Devices Beyond Graphene**, **Arlington, VA**, May 30-31, 2012, **(Kaul)**
- **Interagency 2013 International Conference on Frontiers of Characterization and Metrology for Nanoelectronics**, sponsored by NIST, NSF, CEA-LETI, SUNY Albany, SEMI, SEMATECH, EDS, APS, AVS, & SRC, Maryland, March 25-28, 2013, **(Varshney)**
- **NSF Workshop on the Frontiers of Additive Manufacturing Research and Education**, July 11-12, 2013, **Arlington, VA**, **(Pavlidis)**
- **Workshop on Open Access Phonics Integration Foundry, Washington DC**, (DARPA, AFOSR, ARL, OSA, & OIDA) Sept. 17, 2013, **(Dagenais/Zavada)**
- **OSA Nanophotonic Device: Beyond Classical Limits Incubator Meeting**, May 14-16, 2014, **Washington, DC**, **(Pavlidis/Zavada/Dagenais)**



Student Support and Future Workshops

- Undergraduate student support to attend the “2014 IEEE International Microwave Symposium (IMS)”, Tampa, FL, (Pavlidis)
- Graduate student support to participate in the “5th Annual Non-volatile Memories Workshop 2014, (NVMW 2014)” U. of California, San Diego, March 9-11, 2014, (Varshney)
- Graduate student support to participate in the “2014 Workshop on Compound Semiconductor Materials & Devices (WOCSEMMAD)”, Feb. 16-19, 2014, San Antonio, TX, (Pavlidis)
- US - Ireland Workshop on “Wireless Communications and Sensing – Devices, Components and Systems”, Dublin, Ireland, Sept. 30-Oct. 1, 2014, (Pavlidis/Haddad)
- “Paper Electronics”, NSF (ENG, DMR, CISE), ARL, SRC & USDA, Andrew Steckl, U. of Cincinnati, August 22-23, 2015, (Varshney)
- “Silk Electronics”, John Rogers, U. of Illinois at Urbana-Champaign & Michel Maharbiz, U. of California-Berkeley, June 4-5, 2015, (Varshney)



Other Supported Programs

- **NSF-Ireland Partnerships:**

- **ECCS – 1407765 US/Ireland R&D Partnership:**

Understanding the Nature of Interfaces in Two Dimensional Electronic Devices (UNITE)

PI: Prof. Robert M. Wallace, University of Texas at Dallas

Co-PIs: Prof. Chadwin Young, Prof. Christopher Hinkle, University of Texas at Dallas,

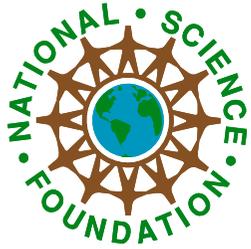
- **ECCSS 1407540 - US-Ireland Collaborative Research on Nano-GaN Power Electronic Devices**

PI: Prof. Zheng J Shen, Illinois Institute of Technology

Co-PIs: Prof. Peter James Parbrook, University College Cork,

Prof. Miryam Arredondo-Arechavala,, Queen's University Belfast

interdisciplinary and more for Ireland....



NSF support UCSC researchers to study endangered Irish language



An image of a flickering tongue may help preserve the endangered Irish language

Ultrasound-based approach:

UC Santa Cruz student Andrew Iliuta wears head gear designed for UCSC researchers

- Linguists estimate that about half of the world's languages are going to be gone within 100 years

- The future of Irish, also known as Gaelic, is uncertain. Once the primary language of Ireland a few centuries ago, now only 1.5 to 3 percent of the population are native speakers

- Grant to document the tongue movement of native Irish speakers using ultrasound.



Questions

Dr. Dimitris Pavlidis

Program Director

Electronics, Photonics, and Magnetic Devices

Division of Electrical, Communications and Cyber Systems (ECCS)

Directorate for Engineering

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<http://www.nsf.gov/eng/eccs/aboutjsp>