

Chemical Engineering @ Columbia University

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Columbia University

Department of Chemical Engineering

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COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science



CHEMICAL ENGINEERING

COLUMBIA UNIVERSITY

www.cheme.columbia.edu

- **The Profession**
- **Columbia CHEME Program**
- **Faculty Research Activities**

What is unique about chemical engineering?

Chemical engineers design and analyze chemically reactive systems on the molecular, system, and global scales.

Breadth:

Chemical Engineering exists at the interfaces of biology, chemistry, materials science, civil and electrical engineering.

Modern chemical engineers have the ability to analyze complex systems that bridge many traditional science & engineering disciplines and isolate the most important phenomena within the problem.

Focus & Depth:

The chemical engineering core education:

- *The basics:* chemistry, physics, math
- **Material and Energy Balances**
- Thermodynamics
- Transport phenomena
- Chemical kinetics
- Control

What do ChemEs do after graduating?

A chemical engineering education prepares you for a huge variety of career choices.

•Industry

use chemical engineering principles to translate concepts into value-added products, design & optimize processes

•Research/Graduate school

work on the frontiers of knowledge to solve open applied or fundamental problems

•Business/finance/entrepreneurship

the analytical skills developed in engineering classes are attractive to employers in all sectors

•Other professional school

- Medical school
- Law school (especially patent law)
- etc.

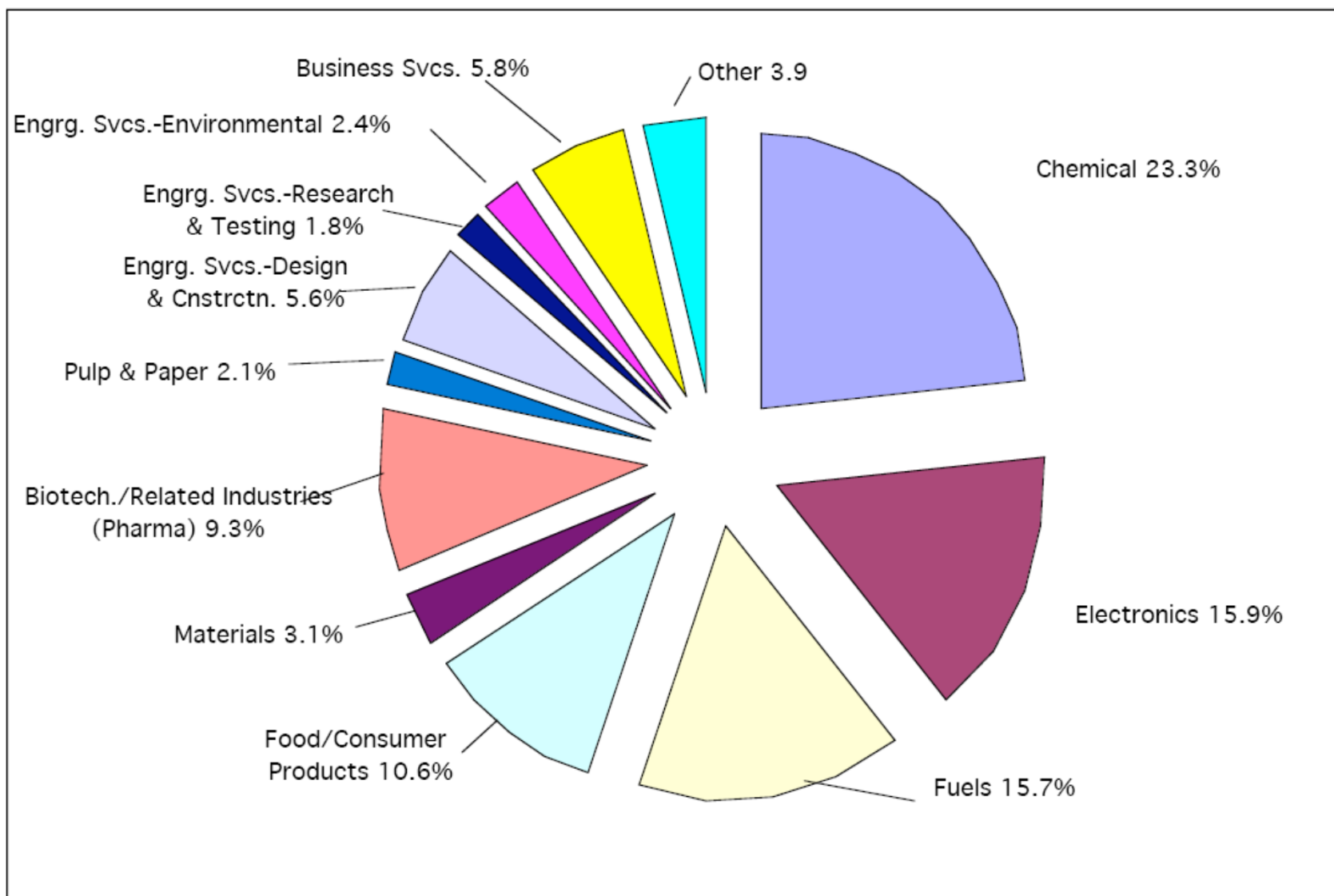
Job Function	N	Median Salary
Construction, Engineering and Procurement	179	\$120,200
Consulting	208	\$100,000
Design	54	\$102,500
Education with Consulting	79	\$160,600
Education without Consulting	147	\$120,000
Equipment Manufacturing*	17	\$103,500
Environmental Engineering	108	\$103,000
Finance / Law / Licensing*	28	\$170,000
Information Management*	21	\$109,600
Instrumentation and Control Engineering	60	\$103,000
Management — Corporate / General	91	\$162,000
Operations and Maintenance	100	\$103,550
Planning and Economics*	25	\$117,000
Plant Management	67	\$123,000
Process Engineering	418	\$100,000
Process Safety, Health and Loss Prevention	94	\$120,000
Product Engineering*	20	\$110,000
Project Engineering	85	\$103,000
Project Management	103	\$114,000
Purchasing*	13	\$102,000
Quality Control*	27	\$86,000
Government / Regulatory Affairs	55	\$95,500
Research and Development	494	\$112,350
Sales and Marketing	70	\$115,000
Technical Service	58	\$108,500
Other	114	\$112,000

Chem.E. salary breakdown by industry – *Chemical Engineering Progress, August 2009*

Industry	N	Median Salary	Mean Salary
Aerospace / Aeronautics / Astronautics	35	\$96,600	\$95,580
Agricultural Chemicals	57	\$110,000	\$111,470
Alternative Energy Sources	55	\$110,000	\$115,106
Automotive*	16	\$92,600	\$98,248
Biotechnology / Life Sciences	109	\$108,133	\$117,578
Business / Finance / Law / Insurance*	18	\$131,000	\$194,894
Catalysts	42	\$123,500	\$136,102
Commodity Chemicals	122	\$110,000	\$114,329
Specialty Chemicals	267	\$106,000	\$112,223
Education	192	\$139,560	\$144,192
Electronics / Computers*	26	\$105,000	\$111,354
Engineering / Design / Construction / Consulting	315	\$116,000	\$123,067
Environmental Engineering	90	\$95,000	\$98,846
Equipment Manufacturing	43	\$100,000	\$106,316
Foods and Beverages	68	\$101,750	\$109,614
Forest Products / Pulp and Paper*	21	\$110,000	\$111,319
Government	63	\$104,000	\$103,041
Industrial Gases*	29	\$120,000	\$133,271
Materials and Composites	34	\$100,850	\$115,359
Metals / Metallurgical Products / Minerals Processing	33	\$110,000	\$121,942
Natural Gas	43	\$103,000	\$118,439
Nuclear Energy and Allied Fields	41	\$115,000	\$126,571
Oilfield Services and Exploration*	23	\$126,000	\$126,718
Paints and Coatings*	18	\$105,000	\$132,756
Petrochemicals and Petroleum Products	92	\$116,900	\$127,474
Petroleum Production / Refining	254	\$130,000	\$134,476
Pharmaceuticals	162	\$110,000	\$121,252
Plastics and Rubber Products	83	\$109,000	\$113,097
Public Utilities	37	\$105,000	\$108,470
Research & Development (R&D)	87	\$108,400	\$119,077
Safety and Health*	28	\$98,480	\$98,599
Soaps / Detergents / Perfumes / Cosmetics*	15	\$106,000	\$108,832
Software	34	\$112,500	\$117,268
Synthetic Fibers / Textiles / Films*	19	\$111,000	\$109,105
Other	164	\$110,000	\$115,850



Breakdown of Industrial Employment for BS Chemical Engineers, Academic Year '00-'01



Is the pay good for chemical engineers?

- Engineers earn some of the highest average starting salaries among those with Bachelor's degrees.
- ChE starting salary usually ranked 1st or 2nd among engineering specialties

Average starting salary offers for engineers, 2007 (Bureau of Labor Statistics, www.bls.gov):

Curriculum	Bachelor's	Master's	Ph.D.
Aerospace/aeronautical/astronautical	\$53,408	\$62,459	\$73,814
Agricultural	49,764		
Architectural	48,664		
Bioengineering and biomedical	51,356	59,240	
Chemical	59,361	68,561	73,667
Civil	48,509	48,280	62,275
Computer	56,201	60,000	92,500
Electrical/electronics and communications	55,292	66,309	75,982
Environmental/environmental health	47,960		
Industrial/manufacturing	55,067	64,759	77,364
Materials	56,233		
Mechanical	54,128	62,798	72,763
Mining and mineral	54,381		
Nuclear	56,587	59,167	
Petroleum	60,718	57,000	

From *Chemical & Engineering News* 2006 salary survey, www.acs.org

Chemical Engineers Are Better Paid Than Chemists

	CHEMISTS	CHEMICAL ENGINEERS
BY EMPLOYMENT		
Full-time	91%	94%
Part-time	3	3
Postdoc	2	1
Unemployed/seeking	3	2
BY EMPLOYER		
Business/industry	62	78
Government/other	7	5
Academia	29	17
Self-employed	2	0
MEDIAN BASE SALARY		
Bachelor's	\$65,200	\$80,000
Master's	77,500	100,000
Ph.D.	95,000	109,200
BY HIGHEST DEGREE		
Bachelor's	20	21
Master's	18	26
Ph.D.	62	53



From the 2008 survey: “The chemical engineering survey respondents ... reported a median base salary of \$112,000, higher than the median \$93,000 for chemists.”

Resources

- American Institute of Chemical Engineers www.aiche.org
- Columbia AIChE student chapter <http://www.columbia.edu/cu/aiche/index.html>
- Career Development center for SEAS www.cce.columbia.edu/seas/
- Profiles of Chemical Engineers
<http://www.careercornerstone.org/chemeng/profiles/chemengprofiles.htm>
- AIChE student internships resources
<http://www.aiche.org/Students/Careers/internships.aspx>
<http://www.aiche.org/apps/careerengineer/index.asp>
- American Chemical Society www.acs.org
 - ACS Scholars (*scholarship program for African American, Hispanic, and American Indian Students*)
http://portal.acs.org/portal/acs/corg/content?_nfpb=true&_pageLabel=PP_SUPERAR_TICLE&node_id=1648&use_sec=false&sec_url_var=region1&uuid=524a9b5b-0c79-4738-a941-67f611eb66f2
- Society of Women Engineers (SWE) www.swe.org
- Society of Hispanic Professional Engineers (SHPE) www.shpe.org
- National Society of Black Engineers (NSBE) www.nsbe.org
- National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) <http://www.nobcche.org/>

Interested in graduate school? Faculty are your best resource.



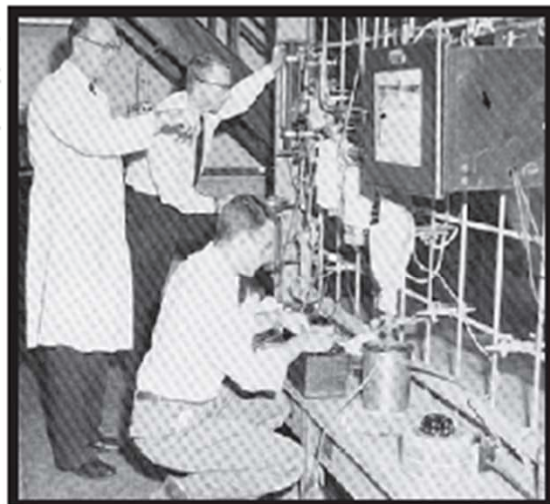
Columbia Chemical Engineering

**Celebrating 100 YEARS of Innovation
Leadership**



Discovery

Chemical
Engineers at
work
1960



Save the Dates!

October 7th, 2005



1960

Columbia CHEME Program

- **Undergraduate Committee**

C.J. Durning, J. Koberstein

S. Banta, V. Ortiz

- **Advising**

- *J. Koberstein: Freshman/ Sophomore*

- *C. Durning: Junior/Senior*

- *S. Banta: Junior/Senior*

- *V. Ortiz: Career Development*

Columbia CHEME Curriculum

- Streamlined program (~132 pts)
- Advising from 1st year available
- 1st year/Sophomore:
 - Math, Chemistry, Physics, Biology
 - Humanities
 - CHEME courses:
 - CHEN E1040 Y: *Molecular Engineering and Product Design*
 - CHEN E3100 X: *Material and Energy Balances*
 - Dual Majors; Minors
 - Study Abroad

Junior / Senior

Engineering Science:

*Thermodynamics, Transport Phenomena,
Molecular Phenomena*

Engineering Practice:

Reactors, Separations, Design, Lab

Elective Content:

- *4 courses, 3000 level or higher, quantitative*
- *2 Engineering, 2 Advanced Natural Science*
- *platform for minor (BME, MSAE, EAEE,
IEOR, Econ...)*
- *platform for specialization*

Upcoming Curricular Changes

Develop two 2 point 3000 level “computing” courses for the Junior year closely connected to instructional needs in the thermo, transport and reactor/kinetics courses

Expand the technical elective content to 5 by removing Molecular Phenomena CHEN E4320 as a requirement

Allow 6 pts of UG research CHEN E3900 for credit towards the degree with the requirement of an UG Thesis

SEAS News

MS Express Program



AMERICAN INSTITUTE OF
CHEMICAL ENGINEERS

AIChE Student Chapter

Award-winning website:

<http://www.columbia.edu/cu/aiche/>

**Student Officers: President,
VP, Secretary, Treasurer,
Industry Liaison, Webmaster**

**Faculty Advisor:
Prof. V. Ortiz**



Departmental Events

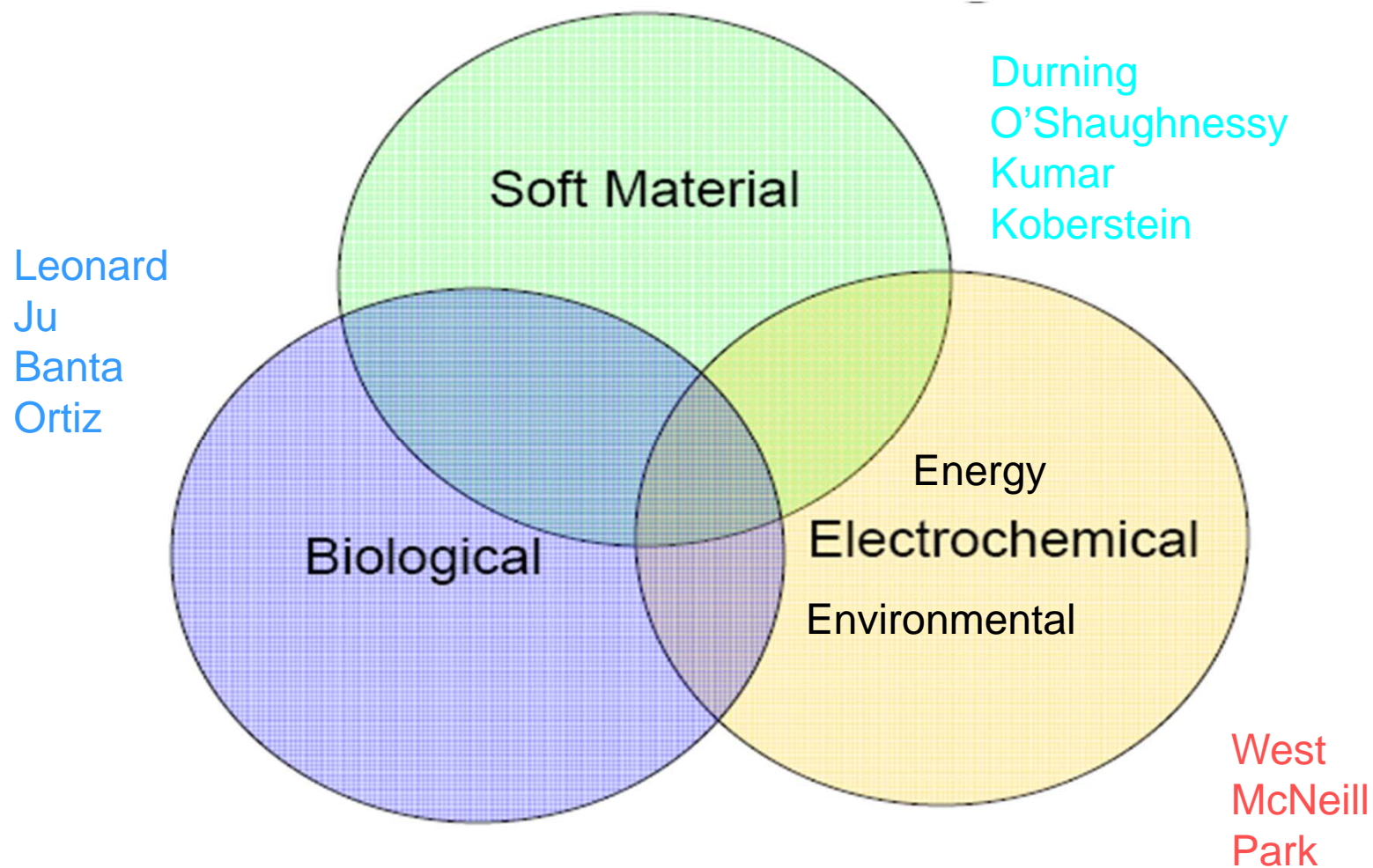
Holiday Parties
Junior/Senior Interviews
Junior Lunch
Senior Dinner

Career Development

AIChE sponsored lectures
Center for Career Education
Advising Seniors 2nd term

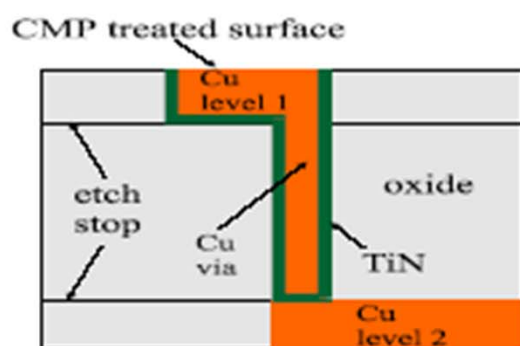
- **The Profession**
- **Columbia CHEME Program**
- **Faculty Research Activities**

FACULTY AND RESEARCH

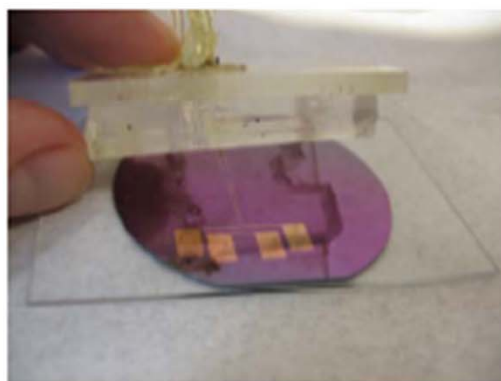


Alan West

Electrochemistry with applications to microfabrication processes, batteries, fuel cells and sensors.



Studies of copper growth and dissolution



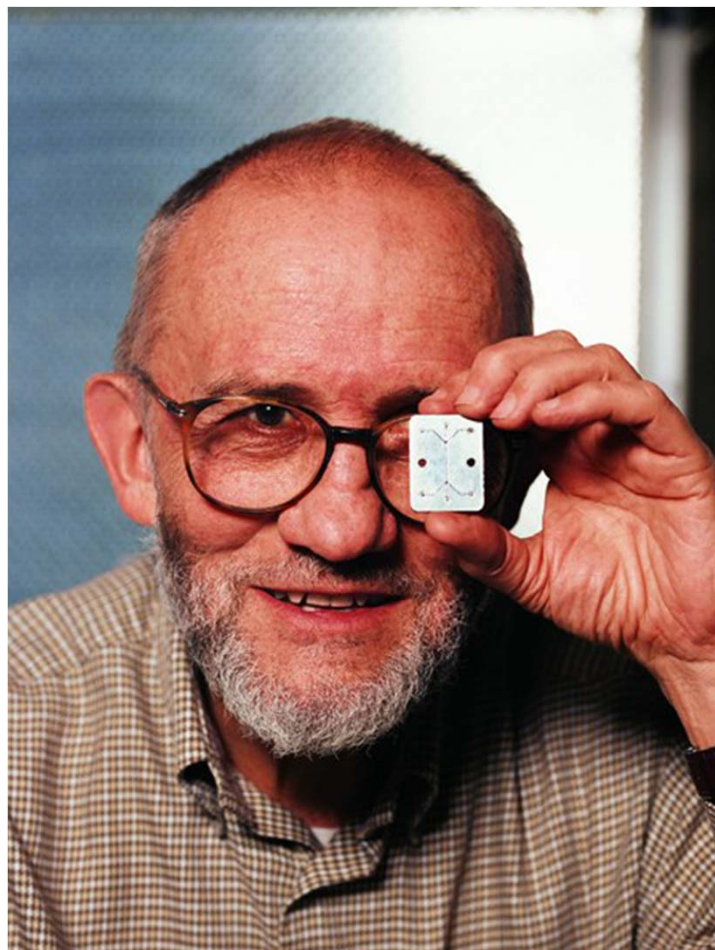
Applications of microfluidics to electrochemical analysis



Dendrite formation in Li/polymer batteries for electric vehicles

From the Fourth United States Microgravity Payload

Columbia CHEME Faculty Biotechnology



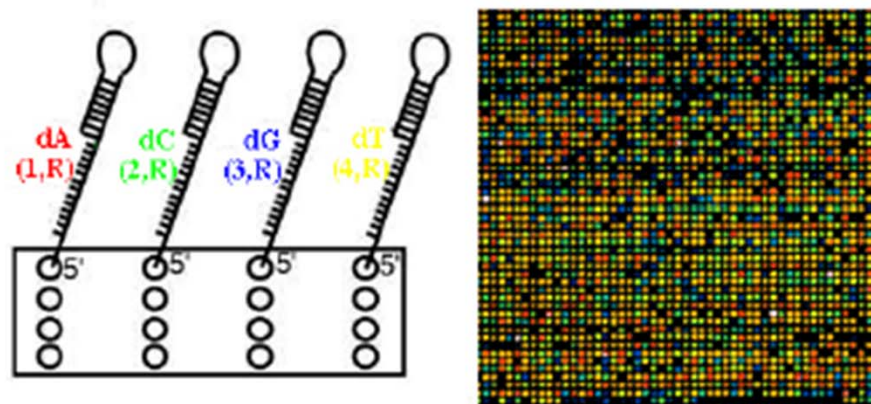
Ed Leonard



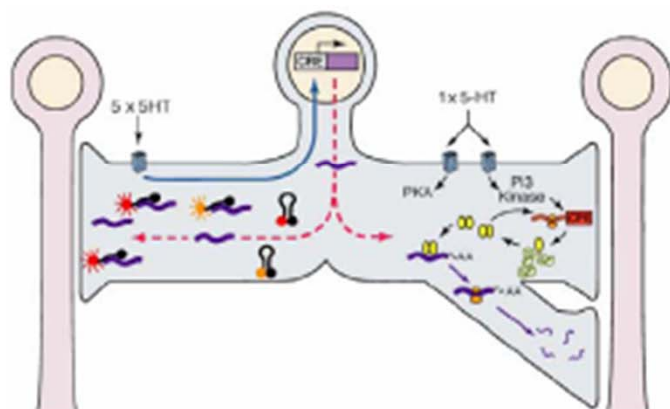
Jingyue Ju

Jingyue Ju

*Molecular engineering for genomic science and engineering
Columbia-NIH Center of Excellence in Genomic Science*



Development of Genome Sequencing Chip System



Novel Molecular Probes for Cellular Imaging

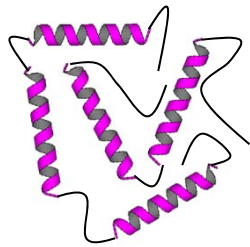
Columbia CHEME Faculty
Biotechnology



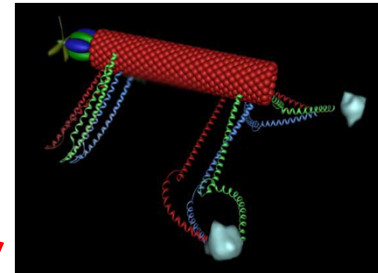
Scott Banta

Banta Group

Protein engineering to enhance material and catalytic properties for biomedical and chemical applications



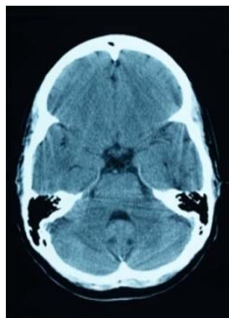
Biomaterials



Nanotechnology



Protein Engineering



Protein Folding
Diseases



Metabolic
Engineering

Columbia CHEME Faculty Soft Materials



Jeff Koberstein

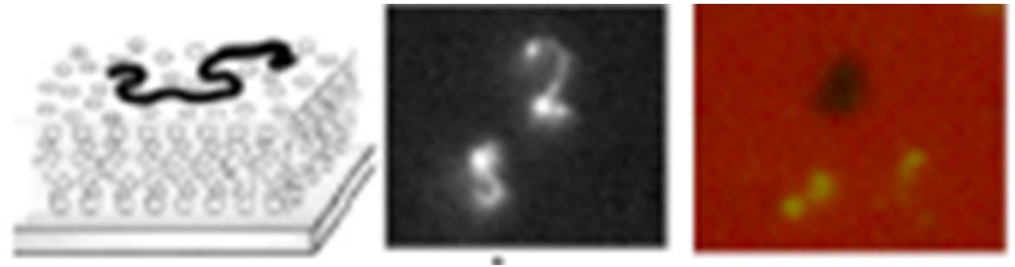


Sanat Kumar
Department Chair

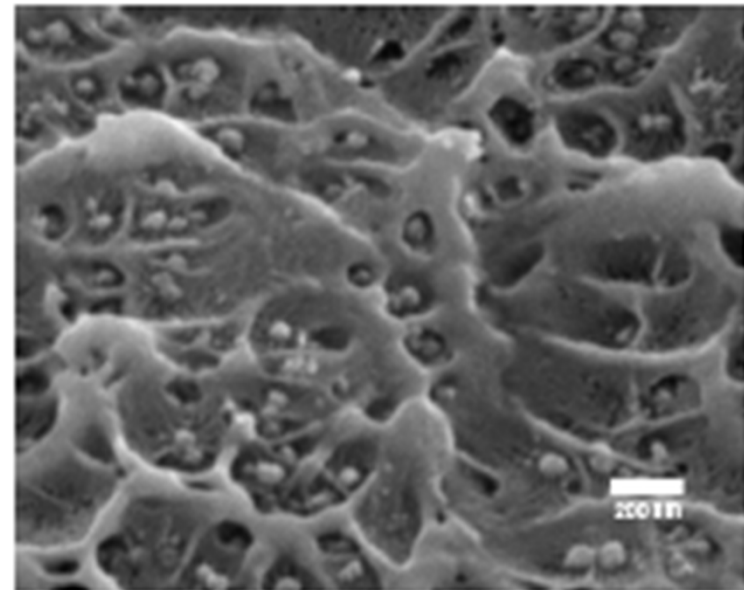
Synthetic & Biological Polymers Theory and Experiment

Sanat Kumar

Can we control protein adsorption ?
Separations, Prion Diseases



How do you make better composites ?



Columbia CHEME Faculty Soft Materials



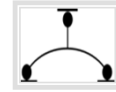
Chris Durning



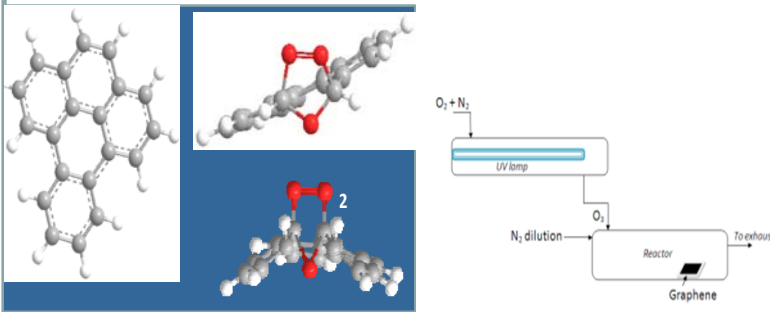
Ben O'Shaughnessy

McNeill Group

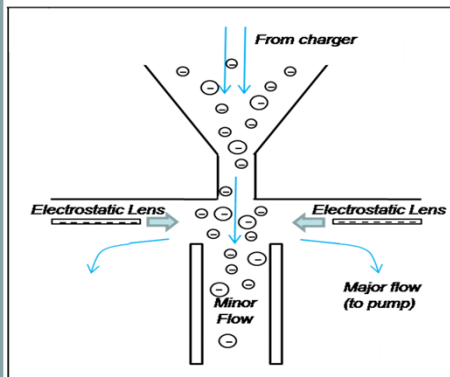
Atmospheric chemistry • Atmospheric aerosols



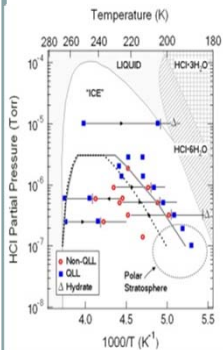
Reactive gas processing of graphene and PAHs



Aerosol characterization technology: AC-CIMS



Atmospheric Chemistry of Ice and Snow



Aerosol Surface Chemistry

