Chemical Engineering @ Columbia University

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Columbia University Department of Chemical Engineering July 15, 2011





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

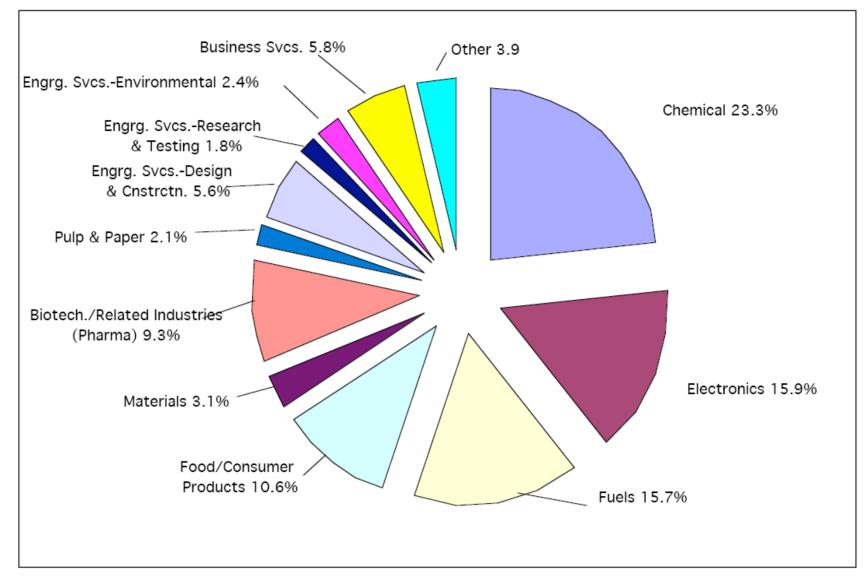
A chemical engineering education prepares you for a huge variety of career choices. Consulting 208 \$100,00 Person of the products of career choices. Education with Consulting 74 \$100,00 •Industry Education with Consulting 74 \$100,00 use chemical engineering principles to translate concepts into value-added products, design & optimize processes Finionee / Law / Licensing* 28 \$170,000 •Research/Graduate school work on the frontiers of knowledge to solve open applied or fundamental problems 91 \$102,000 •Business/finance/entrepreneurship the analytical skills developed in engineering classes are attractive to employers in all sectors 91 \$100,000 •Other professional school Nedical school \$100,000 \$103,000 • Medical school (speecially patent law) 65 \$100,000 \$103,000 • Medical school \$100,000 \$100,000 \$100,000 \$100,000 • Research/Graduate school \$100,000 \$100,000 \$100,000 \$100,000 • Research/Graduate school \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,000 \$100,00		Job Function	N	Salary
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Technical Service 58 \$108,50		Sales and Marketing	70	\$115,000
Other 114 \$112,00		Technical Service	58	\$108,500
		Other	114	\$112,000

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

		Median	Mean	Industrial Gases*	29	\$120,000	\$133,271
Industry	Ν	Salary	Salary	Materials and Composites	34	\$100,850	\$115,359
Aerospace / Aeronautics / Astronautics	35	\$96,600	\$95,580	Metals / Metallurgical Products / Minerals Processing	33	\$110,000	\$121,942
Agricultural Chemicals	57	\$110,000	\$111,470	Natural Gas	43	\$103,000	\$118,439
Alternative Energy Sources	55	\$110,000	\$115,106	Nuclear Energy and Allied Fields	41	\$115,000	\$126,571
Automotive*	16	\$92,600	\$98,248	Oilfield Services and Exploration*	23	\$126,000	\$126,718
Biotechnology / Life Sciences	109	\$108,133	\$117,578	Paints and Coatings*	18	\$105,000	\$132,756
Business / Finance / Law / Insurance*	18	\$131,000	\$194,894	Petrochemicals and	92	\$116,900	\$127,474
Catalysts	42	\$123,500	\$136,102	Petroleum Products			
Commodity Chemicals	122	\$110,000	\$114,329	Petroleum Production / Refining	254	\$130,000	\$134,476
Specialty Chemicals	267	\$106,000	\$112,223	Pharmaceuticals	162	\$110,000	\$121,252
Education	192	\$139,560	\$144,192	Plastics and Rubber Products	83	\$109,000	\$113,097
Electronics / Computers*	26	\$105,000	\$111,354	Public Utilities	37	\$105,000	\$108,470
Engineering / Design /	315	\$116,000	\$123,067	Research & Development (R&D)	87	\$108,400	\$119,077
Construction / Consulting				Safety and Health*	28	\$98,480	\$98,599
Environmental Engineering	90	\$95,000	\$98,846	Soaps / Detergents /	15	\$106,000	\$108,832
Equipment Manufacturing	43	\$100,000	\$106,316	Perfumes / Cosmetics*			
Foods and Beverages	68	\$101,750	\$109,614	Software	34	\$112,500	\$117,268
Forest Products / Pulp and Paper*	21	\$110,000	\$111,319	Synthetic Fibers / Textiles / Films*	19	\$111,000	\$109,105
Government	63	\$104,000	\$103,041	Other	164	\$110,000	\$115,850
							1



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



AIChE Career Services Department www.aiche.org

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, <u>www.bls.gov</u>):

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	

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 SALAR	(
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 <u>www.aiche.org</u>
- Columbia AIChE student chapter http://www.columbia.edu/cu/aiche/index.html
- Career Development center for SEAS <u>www.cce.columbia.edu/seas/</u>
- Profiles of Chemical Engineers <u>http://www.careercornerstone.org/chemeng/profiles/chemengprofiles.htm</u>
- AIChE student internships resources
 <u>http://www.aiche.org/Students/Careers/internships.aspx</u>
 <u>http://www.aiche.org/apps/careerengineer/index.asp</u>
- American Chemical Society <u>www.acs.org</u>
 - 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) <u>www.swe.org</u>
- Society of Hispanic Professional Engineers (SHPE) <u>www.shpe.org</u>
- National Society of Black Engineers (NSBE) <u>www.nsbe.org</u>
- National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) <u>http://www.nobcche.org/</u>

Interested in graduate school? Faculty are your best resource.



Columbia Chemical Engineering

Discovery

Celebrating 100 YEARS of Innovation Leadership

Chemical Engineers at work 1960





October 7th, 2005



Columbia CHEME Program

Undergraduate Committee

C.J. Durning, J. Koberstein S. Banta, V. Ortiz

- Advising
 - J. Koberstein: Freshman/ Sophmore
 - 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



AIChE Student Chapter

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

Award-winning website:

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

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

> Faculty Advisor: Prof. V. Ortiz

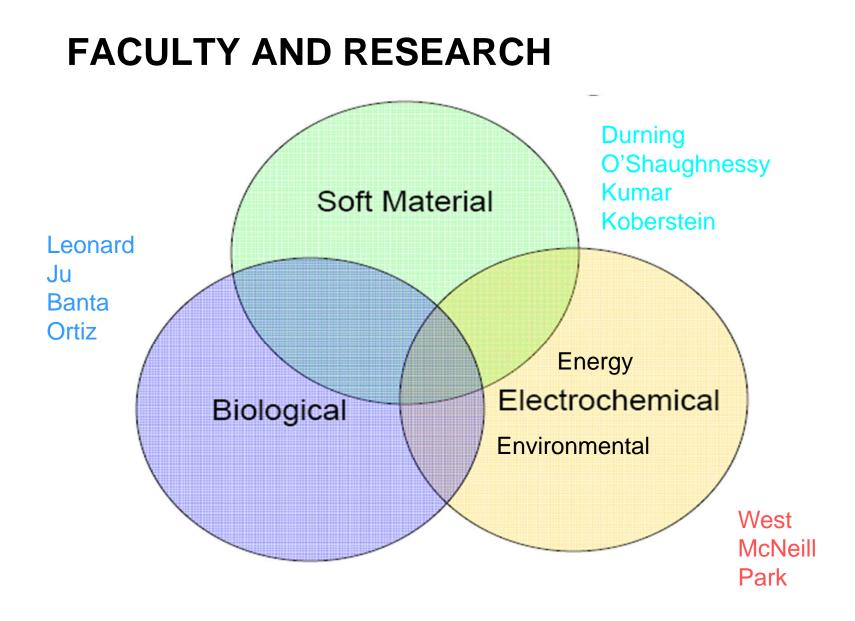


Departmental Events

Holiday Parties Junior/Senior Interviews Junior Lunch Senior Dinner

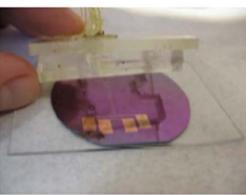
> Career Development AIChE sponsored lectures Center for Career Education Advising Seniors 2nd term

- The Profession
- Columbia CHEME Program
- Faculty Research Activities



Alan West

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

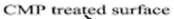


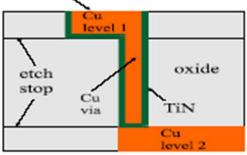
Applications of microfluidics to electrochemical analysis





From the Fourth United States Microgravity Payload

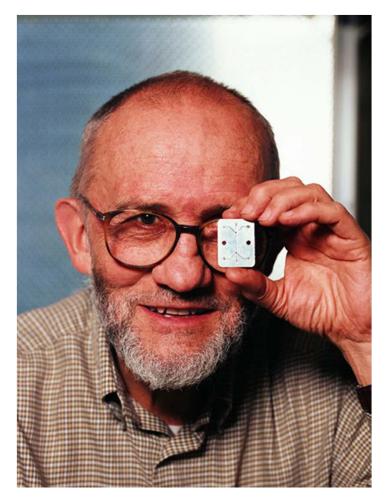




Studies of copper growth and dissolution

> Dendrite formation in Li/polymer batteries for electric vehicles

Columbia CHEME Faculty Biotechnology



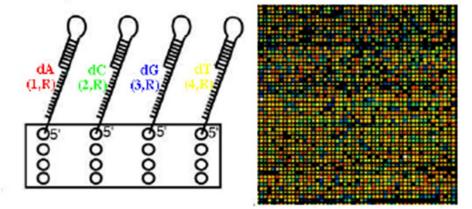


Jingyue Ju

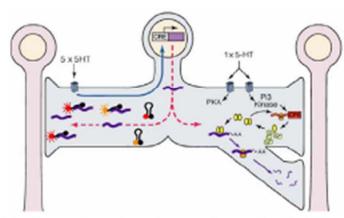
Ed Leonard

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

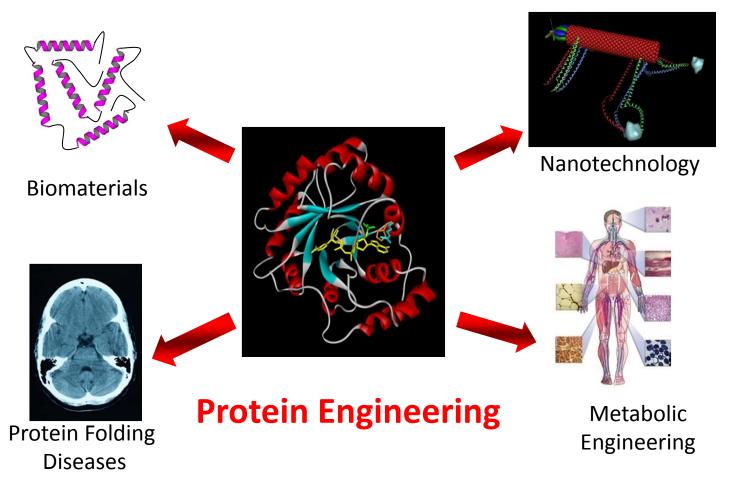


Scott Banta

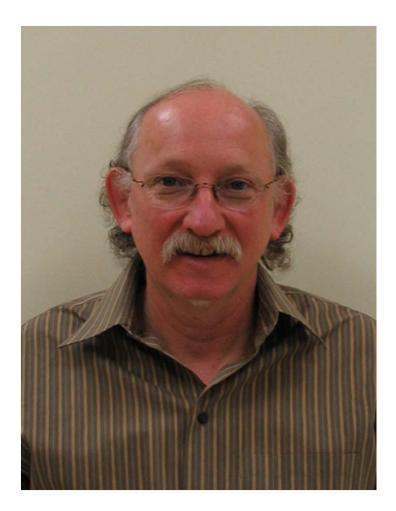
Banta Group

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





Columbia CHEME Faculty Soft Materials



Jeff Koberstein



Sanat Kumar Department Chair

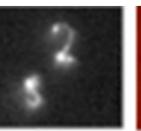
Synthetic & Biological Polymers Theory and Experiment

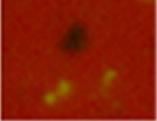
Sanat Kumar

Can we control protein adsorption ? Separations, Prion Diseases

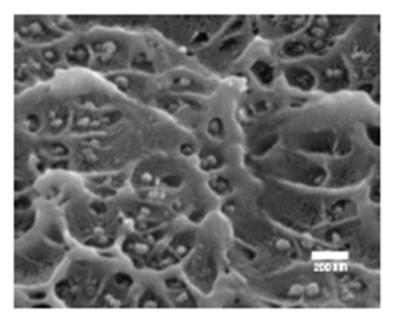




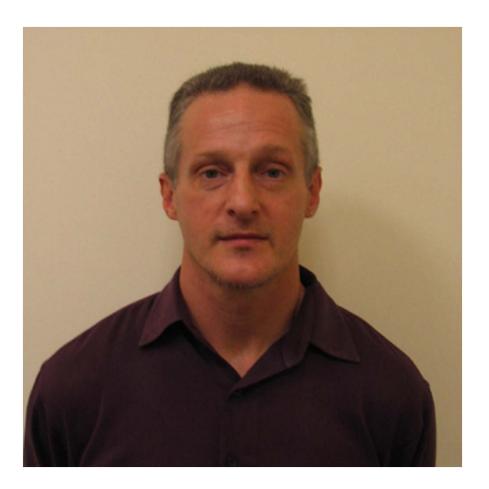




How do you make better composites ?



Columbia CHEME Faculty Soft Materials



Chris Durning



Ben O'Shaughnessy

McNeill Group



Atmospheric chemistry • Atmospheric aerosols

