UCI CCAM Education and Outreach

Education Director

Professor of Materials Science and Engineering
UCI Inclusive Excellence Professor

Education Co-Lead

Associate Professor of Physics & Astronomy (IRG1)

Professor of Physics & Astronomy (IRG2)

Partners:

Director of Academic Innovation, Partnerships

Assistant Dean for Office for Access and Inclusion

Assistant Director Office for Access and Inclusion

UCI CCAM Education and Outreach
CCAM: Education and Outreach Goals

(1) Broadening participation in STEM

(1) Strengthening the STEM workforce in the United States

(1) Creating leaders to address grand challenges in materials research

3.2 million high school graduates in 2019.

65% enrolled in college the following fall; 20% are STEM majors.

ACT performance: 20% of graduates pursuing STEM are ready to succeed. [832,000]

1 million increase in STEM workforce predicted by 2030.
Strength: Comprehensive Education and Outreach Plan

- **Industry & National Laboratories**
  - Visiting Fellows Program
  - Mentorship Network Events

- **Junior Faculty**
  - Faculty Success Program
  - Mentoring Network Events

- **Postdoctoral Scholars & Graduate Students**
  - Seminar Series, Journal Club, Advanced Topics Short Courses, Career Workshops
  - Materials Innovation Slam

- **Undergraduate Students & CC**
  - Undergraduate Research/Mentoring
  - Advanced Topics Course Integration
  - Materials Bootcamp
  - MRSEC REU

- **High School & Community College (CC) Students**
  - Future Materials - OC STEM: Discovery Cube, Mobile Fab Lab, etc.
  - Materials Bootcamp

- **K-12 & Public Outreach**
  - Materials-SPIRE

**Timeline**
- **SEPT**
- **DEC**
- **MAR**
- **JUN**
CCAM Activities: Engage and Cultivate Capacity
Along Pathways to STEM Careers

**Undergraduate Students (UG)**
- Materials Bootcamp
- Materials REU
- Advanced Topics Course Integration

**Junior Faculty**
- Faculty Success Program
- Mentoring Network Events
- Seed Projects

**Postdoctoral Scholars (PS) & Graduate Students (GS)**
- Materials Innovation Slam
- Advanced Topics Short Courses
- Seminar Series / Journal Clubs

**High School & Community College Students (CC)**
- Materials-SPIRE (M-SPIRE)
- Materials Bootcamp

**K-12 & Public Outreach**
- Future Materials - OC STEM: Discovery Cube, Mobile Fab Lab, etc.

Engagement, Capacity and Continuity Trilogy
Diversity, Equity, Inclusion and Belonging
Outcomes

Dr. Lubella Lenaburg, External Evaluator
Evaluation and Assessment Program Manager at UCSB’s Center for Science and Engineering Partnerships with >15 years of experience evaluating STEM research centers.

100% MRSEC junior faculty establish independent research funding in 3 yrs and take up leadership positions at yr 6

> 50% of MRSEC junior faculty receive national awards in 3 yrs

Faculty hires exceed national availability pool in terms of diversity

> 95% MRSEC PhD students complete degree

Annually, 10 Materials Slam participants

5 MRSEC PS/GS receive academic positions w/in 5 yrs

MRSEC PS/GS diversity 50% female and 16% URM, doubled from baseline

Mentor 72 REU UG students w/ > 50% URM

> > 95% complete STEM UG degree

> 25% of the students attend graduate school in MSE or equiv.

Increase diversity of UG in UCI MS&E to 50% URM and 50% female

Mentor 72 students with > 50% URM participants

> 70% of CC students transfer to 4-yr institution

Engage additional CC students in Materials Bootcamp

K-12 & Public Outreach

Future Materials - Mobile Fab Lab, etc.

Education modules reach: 100 & 500 students by yr 3 & 5, respectively

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Junior Faculty Development

- 9 Junior faculty (assistant professor)
- 5 URMs, 5 women

- Co-authored publications
- Collaborative funding
- National awards/ nominations
- Advancement to tenure and leadership roles

Seed Funding

- NSF Outstanding Early-Career Investigator Award
Goal: 50% women, 16% URM  
Current: 25% women and 8% URM  

Partner with campus recruitment fellowship programs and offer MRSEC recruitment fellowship to increase diversity.
Shapeshifting Bio-Legos With Peptide Building Blocks

Peptide building blocks designed to assemble and disassemble in response to environmental stimuli. Stimuli responsive structural changes can gate complex, hierarchical assembly processes for molecularly defined material scaffolds.

Acidic  Basic

pH  1  7  14

Neutral
**STEM-Corps collaboration with Industrial Advisory Board**

**Goal:** Engage (undergraduate) students in industry driven research. Foster the development of problem solving skills

**Process:** Students research and report state of the art. Define known technology before proposing and testing solutions.

**Active Learning:** Students test hypotheses via experiments on campus and in industrial laboratories.

www.pnas.org/cgi/doi/10.1073/pnas.1916903117
Active Learning Narrows Achievement Gap
Example Project: Understand state of the art in Ti alloys. Design Ti-based alloys

Fabricate using casting. Characterize resulting microstructure using optical and electron microscopy, energy dispersive spectroscopy and X-ray diffraction.

Test: Hardness and tensile strength of fabricated structures. Refine fabrication process.

Inaugural cohort: 10 undergraduate students. Establishing new industrial projects.
STEM-Corps and Future Materials

Train science advocates (CCAM participants and MSE students) to engage and educate K-12 students on materials research.

- Introduce the scientific method,
- Introduce experimental system and allow participants to form a hypothesis. Conduct experiments.
- Participants form new questions about experiments

**Virtual Activities: The Science of Cooking series (K-8)**

**Example Workshop:** Dissolution of candy canes in acidic and neutral conditions and varying temperature.

**Imaging:** 50 foldscope kits distributed via partnership with Corona Public library

104 K-8 Students engaged in year 1 virtually
Train science advocates (CCAM participants and MSE students) to engage and educate K-12 students on materials research.

- Introduce the scientific method,
- Introduce experimental system and allow participants to form a hypothesis. Conduct experiments.
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**Summative Assessment of (pre)kindergarten students:**

- More than 80% of participants want to go to college and pursue a career as a scientist or engineer
- Parents: “It was clear that you reached kids of all ages very effectively, ... WOW!!!”; “I am so impressed ... and clearly my 4 year old was, too, because (they) wanted to repeat the experience today by teaching (their) grandparents how to make cake in a cup on FaceTime.”
- Participants: “‘I will make a hypothesis and test it out’, ‘I’ll have a hypothesis!’


**Over 400 K-12 students!** In Irvine, Santa Ana, and Los Angeles Unified School Districts, having diverse ethnic, income and parent education level demographics.
**Goal:** Engage students by educating them about materials challenges in state of the art technology.

**Lesson:** Relationship between processing, microstructure and performance of ceramic materials.

**CCAM Research:** Spark plasma sintering of ceramic alloy increases hardness by 28%

What I enjoyed in this activity was being able to build the fold-scope and getting able to test it out in the end.

Wang, Qin, Lei, Kisslinger, Rupert, Luo, Xin, J. Eur Ceram. Soc., 41, 5380 (2021)
Future Materials: Partnerships with Local High Schools Education Module: Structure– Function Relationships

**Education module:** Perform alginate cross-linking and measure physical properties.

**CCAM Research:** Electrically fueled dissipative assembly of supramolecular systems in IRG2

CCAM manuscript: Selmani, Schwartz, Mulvey, Wei, Grosvirt-Dramen, Gibson, Hochbaum, Patterson, Ragan, Guan JACS accepted (2022)

**Objective:** Understand how crosslinking density affects mechanical properties of polymers.

**Early College High School in Costa Mesa** (Newport-Mesa USD, 62% Latino and 64% socioeconomically disadvantaged)

**Segerstrom High School in Santa Ana** (Santa Ana USD, 91% Latino and 74% socioeconomically disadvantaged).

Guan, Hochbaum and Ragan Laboratories
Inaugural REU Cohort

Women 67%
Men 33%

100%
58%
42%
25%

UR
URM
Hispanic/Latino
First Generation

❖ 67% low-income
REU Outcomes

Likelihood to of interns to conduct research in remainder of B.S. degree

- Extremely likely: 91%
- Somewhat likely: 9%

Do interns feel more prepared to conduct scientific research as compared to the start of the program

- Much more: 45%
- Somewhat more: 45%
- A little more: 10%
- 64%

Learned new methods for collecting data
- 64%

Learned new methods for data analysis
- 73%

Learned how a research lab functions
- 55%

Improved my science communication skills
- 82%

Learned how to find and interpret scientific literature
- 55%

None of the above
- 0%
REU Outcomes

Likelihood to take additional coursework related to materials
- Extremely likely: 82%
- Somewhat likely: 9%
- Neither likely nor unlikely: 9%

Likelihood to attend graduate school
- Extremely likely: 46%
- Somewhat likely: 27%
- Neither likely nor unlikely: 18%
- Somewhat unlikely: 9%

How much
- 5 graduates in Spring 2022, 3 interns will attend graduate student in Fall!

To understand what to expect from a STEM graduate program
- Much more: 55%
- Somewhat more: 45%
- No more: 0%

To apply to a STEM graduate program
- Much more: 45%
- Somewhat more: 18%
- Slightly more: 9%
- No more: 0%

To perform well in a STEM graduate program
- Much more: 45%
- Somewhat more: 55%
- Slightly more: 0%
- No more: 0%
M-Spire: Skill development in high school and CC Students

General Atomic and Molecular Electronic Structure System (GAMESS) is a computational chemistry code that is hosted on the NSF nanoHUB

Machine Learning – feature selection

Apply to image analysis
M-Spire and REU Summer 2022

M-Spire Cohort:
47% URM
60% Women
27% Low-income
26% first generation

Materials REU interns:
50% URM
20% female
50% low-income
20% first generation

Zachary Urbach, Program Coordinator