

Title: Energy harvesting, storage and efficiency - Renewal of MACES
Institution: University of California, Merced
City/State: Merced, CA
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Summary: Overview: MACES (Merced nAnomaterials Center for Energy and Sensing) opened in the summer of 2015 as the first extramural funded center at UC Merced. MACES has forged a collaborative dynamism of faculty and students with collective strengths and complementary expertise to tackle the energy and sensing challenges outlined in the 2014 NASA Strategic Plan. This effort has produced impressive research outcomes with 80 research publications and 8 collaborative projects with NASA. MACES helped secure \$13.6 M in extramural funding, including \$2.8 M for state-of-the-art instruments that have fueled the rapid transformation of the campus' materials research infrastructure, which surpasses that of many well-established universities.

Located in the underserved San Joaquin Valley, 87% of UC Merced's undergraduates come from underrepresented groups (URG) or are first-generation students. MACES is uniquely positioned to inspire and guide students through STEM training. Through extensive mentoring and training, 97% of the 105 MACES-funded undergraduate students have completed their degrees to pursue STEM careers or PhD training. Over 50 MACES-funded graduate students will have received either PhD or MS degrees. By creating and presenting hands-on STEM training modules, MACES has helped 1,550 local high school students to meet the New Generation Science Standards. MACES has created an effective model for integrating research, education, and outreach to produce a diverse STEM and space workforce, which meets the four MIRO objectives.

Proposed Work: MACES will focus its research efforts on energy materials research for space exploration. Long-duration and deep space missions hinge upon the availability and efficient use of energy sources, which require transformative breakthroughs in (1) high-performance solar energy harvesting, (2) high-energy and high-power energy storage systems and (3) new materials platforms to improve energy efficiency. These areas have evolved from the initial funding period and are interrelated based on complementary research tools and approaches: (1) multi-scale computation to explore material structure-property relationships; (2) chemistry and materials science to develop novel synthesis and fabrication methods for emerging materials and systems; and (3) physics and engineering to characterize and evaluate material function and applicability. MACES has already assembled a team of faculty with relevant and complementary expertise and has demonstrated success via 28 collaborative peer-reviewed journal papers. MACES expects to produce transformative scientific knowledge and innovative technology solutions for space and terrestrial applications.

MACES will work to close educational and socioeconomic gaps by preparing URG students to become highly qualified STEM professionals. We will expand unique educational opportunities

through NASA mission-oriented research training. MACES will work closely with local high school districts nearby community colleges, and California State University campuses to recruit students especially from URGs. To further increase URG PhD completion rates, MACES will provide resources for more effectively mentoring, among other initiatives.

We will take a multi-pronged approach to sustainability. Through grantsmanship workshops, MACES will prepare students to apply for fellowships. We will broaden and deepen our alliance with NASA through additional joint research endeavors. We will expand our partnerships with two nearby DOE National Labs through research and co-mentoring students, to potentiate securing future DOE grants. Seed grants will catalyze new research frontiers for winning federal and private grants.

Among other strategies, MACES will recruit 2 to 3 stellar faculty. With MACES planning to establish itself as a university Organized Research Unit in 2021, the Center is poised for winning major center grants, ensuring future sustainability of MACES' established programs.