

DEPARTMENT OF MECHANICAL AND MATERIALS ENGINEERING  
COLLEGE OF ENGINEERING AND APPLIED SCIENCES

FOR APPLICATION YEAR: 2021

PROJECT TITLE: Additive Manufacturing of Advanced Materials

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**Project Description****Project Scope**

Interest in functional advanced metal alloy parts is on the rise across multiple industries. In principle, metal additive manufacturing can fabricate such parts. However, severe limitations are present in conventional directed energy deposition (DED) based methods, primarily due to thermal complications. Electrochemical additive manufacturing (ECAM)., as a nonthermal process, has the potential to overcome such limitations and fabricate alloy parts of complex shapes and composition distributions. This allows for novel parts to be produced for varying applications. While the ECAM process has been extensively studied using a system of one or two metals, the ability to control functional properties, and use more metals, is relatively unexplored. Control of the process at this scale requires rigorous selection of input process parameters, study of their effect on microstructure/composition, and characterization of functional properties.

**Project Goals**

Experimental goals include:

- Determination of the effective process conditions in which to run deposition. This involves testing behavior under different chemical, electrical, and geometrical conditions.
- Designing a method of tool path planning to build a 3D CAD model - with functional material composition encoded - under a given set of process conditions.
- Evaluating the deposition behavior using in-process monitored signals and post-process imaging and characterization methods.

#### Learning opportunities for students

Participating in this project will expose the undergraduate student to hands-on, interdisciplinary research. Students will build have the opportunity to build rare and valuable skills in studying physical phenomena from first-principles, experimentation characterization methods, analog hardware design, and/or modeling of the process at the atomic scale. Fundamental research skills will be covered including literature review, presentation, and report writing. The undergraduate student will also be encouraged to begin building a professional body of research work by presenting the work at either a conference and/or preparing a paper for journal publication.

Final deliverables will include:

- Experimental proof-of-concept on student-determined CAD files
- Documentation on the problem-solving process to generate each shape

Students will gain exposure to:

- Providing new knowledge on an emerging manufacturing technique
- Conducting a literature review
- Hands-on experiments with an electrochemical setup and hardware
- Coding of tool path planning algorithms and microprocessor control

operations

- Problem solving
- An excellent opportunity to exercise your initiative, creativity, critical thinking, scientific judgment, scientific knowledge, problem solving, and teamwork skills

#### Contact

Please contact Dr. Sundaram ([murali.sundaram@uc.edu](mailto:murali.sundaram@uc.edu)) if you are interested in selecting this as your project.