We envision the proposed ML approaches will significantly accelerate the search of multiphase multi-principal component alloys, providing novel alloy systems to tailor the mechanical performance. The created dataset and the developed ML will allow the promising alloy composition for future computational and experimental investigation towards the design of novel RHEAs for aeronautical applications.

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Nano-based Ceramic-metal Composites to Support Planetary Agrosystems (Appendix D: Crop Plant Stress Tolerance for Space Exploration)

Louisiana State University

Prof. T. Gregory Guzik

This proposal is in response to the FY2021 NASA EPSCoR Rapid Response Research Opportunity Appendix D: NASA SMD Biologicala and Physical Science: Crop Plant Stress Tolerance for Space Exploration.
MicroRNAs (miRNAs) are small single-stranded RNAs with low protein-coding potential. miRNAs act as negative post-transcription regulators of their messenger RNA (mRNA) targets via mRNA degradation and translational repression. Although plant miRNAs target only a small number of mRNAs, these play a critical role in many plant developmental processes. Biotic and abiotic stresses result in tissue-specific changes in miRNAs' expression. Plant response to two different abiotic stresses is unique and different from stresses applied individually. Tolerance to a combination of other stress conditions, particularly those that mimic the field environment, is the focus of this research project. Metal nanoparticles (mNPs) can enhance crop production and mitigate the impacts of plant stressors. Ceramic-metal nanoparticles (cerametals), composites of mNPs, and halloysite nanotubes offer many advantages, including high surface area, stability, and biocompatibility. We propose that cerametals affect many aspects of leafy greens or tomato plant growth and enhance these plants' tolerance to many plant stressors.
Plants will be exposed to different combinations of stresses at the same time under field conditions. The relationship between cerametal addition, plant stress responses, and changes in miRNA expression will be studied. A proprietary predictive algorithm and machine learning will be used to analyze large data sets generated. In concert, the effects of stress (+/-) cerametals on plant germination, growth, propagation, plant structures, and functions will also be assessed. Improved sustainability, stress tolerance, and reducing the impact of plant pathogens is critical as we prepare for the exploration of the Moon and Mars. Nano-based ceramic-metal agrotechnology will be a cheap and efficient way to reduce water needs, use available soil, and produce plants for biogenerative life support systems in Lunar and Mars habitats.