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Develop Metal -Organic Frameworks (MOFs) Adsorbets for Air Revitalization System

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Project Summary

The environmental control and life support system (ECLSS) in the International Space Station (ISS) is a critical system to ensure a healthy and safe living and working environment for the astronauts. An important part of the ECLSS system is the atmosphere control, in particular, carbon dioxide (CO_2) removal as shown in Figure 1. One method to remove CO_2 is ISS is to go through Sabatier Reaction:

$$CO_2 + 4H_2 \leftrightarrow 2H_2O + CH_4$$

in which carbon dioxide reacts with the excess hydrogen from water electrolysis, preserving the water. The Sabatier reaction is an exothermic, reversible reaction. High temperature (~300 °C) is required to enable the working catalysts, but it makes the reaction favor the reverse reaction. One way to move the reaction equilibrium to favor the forward reaction is to increase the concentration (pressure) of the reactant, i.e., CO_2. Since the concentration of CO_2 in the living condition is in the level of 10^3 ppm level, high surface area absorbents, or absorbers are used to concentrate the CO_2 before the Sabatier reaction. The desired absorbents are of high surface area, pore volume, selective, stability, recyclability, and resistance to poisons such as methane and sulfur containing chemicals from human metabolism.

Life support

Figure 1. A simplified schematic of oxygen cycle in the air revitalization system.

The *goal* of this proposed research is to explore the possibilities of metal-organic frameworks (MOFs) as novel porous structures that can be chemically functionalized to attain molecule-specific adsorption properties. MOFs represent a new direction in porous materials

research that could lead to the creation of designer - specific multifunctional materials. The rich field of coordination chemistry provides a versatile platform on which these materials may be assembled using an almost infinite set of building blocks.

Student Primary Responsibilities:

• Develop a reproducible recipe to synthesize the MOFs
• Characterize the MOFs using proper techniques
• Evaluate the CO_2 absorption performance
• Assist in writing reports describing procedures used
• Assure all job activities adhere to UAH Environmental, Health and Safety requirements.

Qualifications

• Strong chemistry background, preferred candidates should have chemistry lab experience • Understanding of thermodynamics and reaction kinetics

Mentor Supervision and Interaction

Our multi-disciplinary research group currently consists of 1 faculty, 1 senior researcher, 3 PhD students, 3 undergraduate researchers and 2-3 high school researchers during the summer. The RCEU undergraduate student will discuss research progress and plan for the next stage with the faculty on a daily basis. The lab activity will start with shadowing one of the PhD students in the group, and gradually lead to individual activity under supervision by the senior members in the group.

Individual Meeting. A definite schedule of individual meetings and team meetings is adopted weekly in our group. The group member will meet with the mentor in an informal fashion to discuss recent progress.

Group Meeting. Our group holds weekly group meetings. The perspective student will participate in the group meeting and be able to interact with graduate students and faculty members. The RCEU student is expected to present in the group meeting, covering literature review and research progress.

Assessment

The minimum requirement for the RCEU student is to at least present at UAH by the end of the program. The student is encouraged to submit their work to be published by the UAH undergraduate research journal – Perpetua.