**Effect of microgravity on impurity retention kinetics in small pharmaceutical crystallization from solution**

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**Purpose:**

Crystallization in reduced gravity conditions has been going on since the 1980s, where results generally promised larger and purer crystals. Our team found that many of the findings were primarily retrospective, with limited real-time discoveries. The purpose of our research is to study the effects of microgravity on impurity incorporation & retention kinetics in pharmaceutical crystallization from solution using dyes as guest impurities. The aim is to collect unprecedented visible, reproducible, and quantifiable data on crystal nucleation and growth from solution. Our study seeks to advance understanding of the mechanisms and conditions governing crystal impurity incorporation.

**Methods:**

We will acquire nucleation data and crystal growth imaging using a Pharmaceutical In-space Laboratory on the International Space Station. The methods are limited because of the in-space setting. We are using microscope color-imaging, limited temperature cycling, and antisolvent crystallization methods. The key factor is finding the perfect supersaturation ratio (SSR) to maximize results in the relatively fixed space station environment. Current pre-flight testing methods include heavy solubility screening (HPLC), gravity dependent test-runs using the Redwire PIL-box system, and single crystal growth characterization in the presence of an impurity.

**Results:**

Current results show promise for systems using Acetaminophen (host crystal) and Sulforhodamine B (dye, guest crystal) or curcumin (colored guest crystal), Ibuprofen (host crystal) and Vitamin B (colored guest crystal), as well as an inorganic option in potassium sulfate (host crystal) with Acid Fuchsin (dye, guest crystal). Final results are outstanding (Launch in April 2026).

**Conclusions:**

It is difficult to obtain reliable data in a microgravity setting. To industrialize space, enhancing capabilities is the first directive. From a kinetic perspective, it is likely that impurity incorporation/retention is decreased in the absence of earth’s gravitational forces. This could contribute to enhanced growth (larger crystals) and greater levels of purity than on earth, but supporting data remains to be seen.

**Keywords:**

Microgravity, Crystallization, Impurity Retention Kinetics