ORGANIC CRYSTAL GROWTH EXPERIMENT FACILITY
(13-IML-1)

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The interesting nature of metal-like organic compounds composed of charge transfer complexes has been recently realized. Crystals of these complexes can usually be grown by the solution crystallization method. Some pure crystals of such organic metal-conductors behave as organic superconductors at cryogenic temperatures where they have unique physical properties, for instance, anisotropic electronic conduction. Their low dimensional metallic conductivity seems to depend largely on their singularity of the crystal structure. In order to investigate the properties of metallic conduction, it is necessary to grow large, defect-free single crystals from the charge transfer complexes. It is difficult to grow such organic single crystals on Earth, especially from the chemical reactions through diffusion-controlled process in the solutions, because of gravitational disturbances, or sedimentation. The difficulty primarily arises from the density differences between the two reactant solutions, the donor and the accepter, and between the crystals formed and the solutions. Typical ground-grown crystals for the charge transfer complex, TTF $\{Ni(dmit)_2\}_2$, a compound which could exhibit superconductivity below a critical temperature (T_c), are small needle-like fragments (2 mm x 0.1 mm). The crystal size obtained in ground experiments is never large enough to determine the physical properties, such as anisotropic superconductivity.

The IML-1 Organic Crystal Growth with G-Gitter Preventative Measure (OCGP) experiment is expected to grow a single crystal large enough to allow its intrinsic physical properties to be measured and its detailed crystal structure to be determined. This experiment also attempts to assess the experimental conditions including the microgravity environment for further investigation of the fundamental process of solution crystallization, nucleation, and growth from supersaturated phases including chemical reactions. Microgravity disturbances, G-jitter, may be an important environmental factor in the experimental method to assess.

The Organic Crystal Growth Facility (OCGF), the major hardware component of the OCGP experiment, consists of two independent crystallization chambers (OCCs) and a mounting structure. Two identical experiments will be carried out in the facility. One of the OCCs is mounted on a vibration damping structure, the other is mounted directly to the Spacelab rack without any damping. The vibration damping effect on organic crystal growth can then be carefully studied by comparing the crystals formed in the two OCC's. OCGF is illustrated in Figure 1. The OCC is illustrated in Figures 2(a) and 2(b).

TECHNICAL DATA FOR THE OCGF

- OCGF
  dimension: 440W x 266H x 360D (mm)
  weight: <12 (kg)

- OCC
  dimension: 80W x 130H x 301D (mm)
  capacity: 75 (cm^3) (central reaction cell)
  73 (cm^3) (each of two side cells)

- VIBRATION DAMPING MATERIAL: Epoxy-based polymer

The OCC is made of quartz glass and is divided into three rectangular cells filled with organic solvent and reaction compounds. The glass chamber is entirely covered by an aluminum housing. The reaction will be initiated manually by opening holes of the two partitions between the cells. For this manual operation, a rotary handle is located in front of the outer housing. The reaction and crystal formation occur in the central cells of the OCCs. The acceptor and donor reactants will meet there by diffusion. The crystal growth is a slow process and usually requires more than 1 week to complete. The two reactants, used as solutes in this experiment, are the organic compounds $(TTF)_3(BF_4)_2$ and $(Bu_4N)\{Ni(dmit)_2\}$. Acetone is used as the solvent. The amounts of these materials per each OCC cell are as follows:

$(TTF)_3(BF_4)_2$, Tris-tetrathiafulvalene-bis-tetrafluoro borate: 47 mg

$(Bu_4N)\{Ni(dmit)_2\}$, Tetrabuthylammonium-nickel-bis-dmit: 166 mg

$(CH_3)_2CO$, Acetone: 221 cm^3

The reaction forms the insoluble charge transfer complex TTF $\{Ni(dmit)_2\}_2$ or TTF-bNbD (Tetrathiafulvalene-bis-nickel-bis-dmit) for brevity, where "dmit" stands for [4,5 dimercapto-1,3 dithiol-2 thione], or (C_3S_5), or isotrithione-dithiolate.

Experiment deactivation is accomplished when the crew rotates the handle of each OCC on board, thus closing the holes in the partitions. After the mission, space-grown crystals will be carefully analyzed, focusing on the difference in crystal structure and its morphology, electrical and magnetic properties, superconductivity and other important properties which are due to microgravity effects.

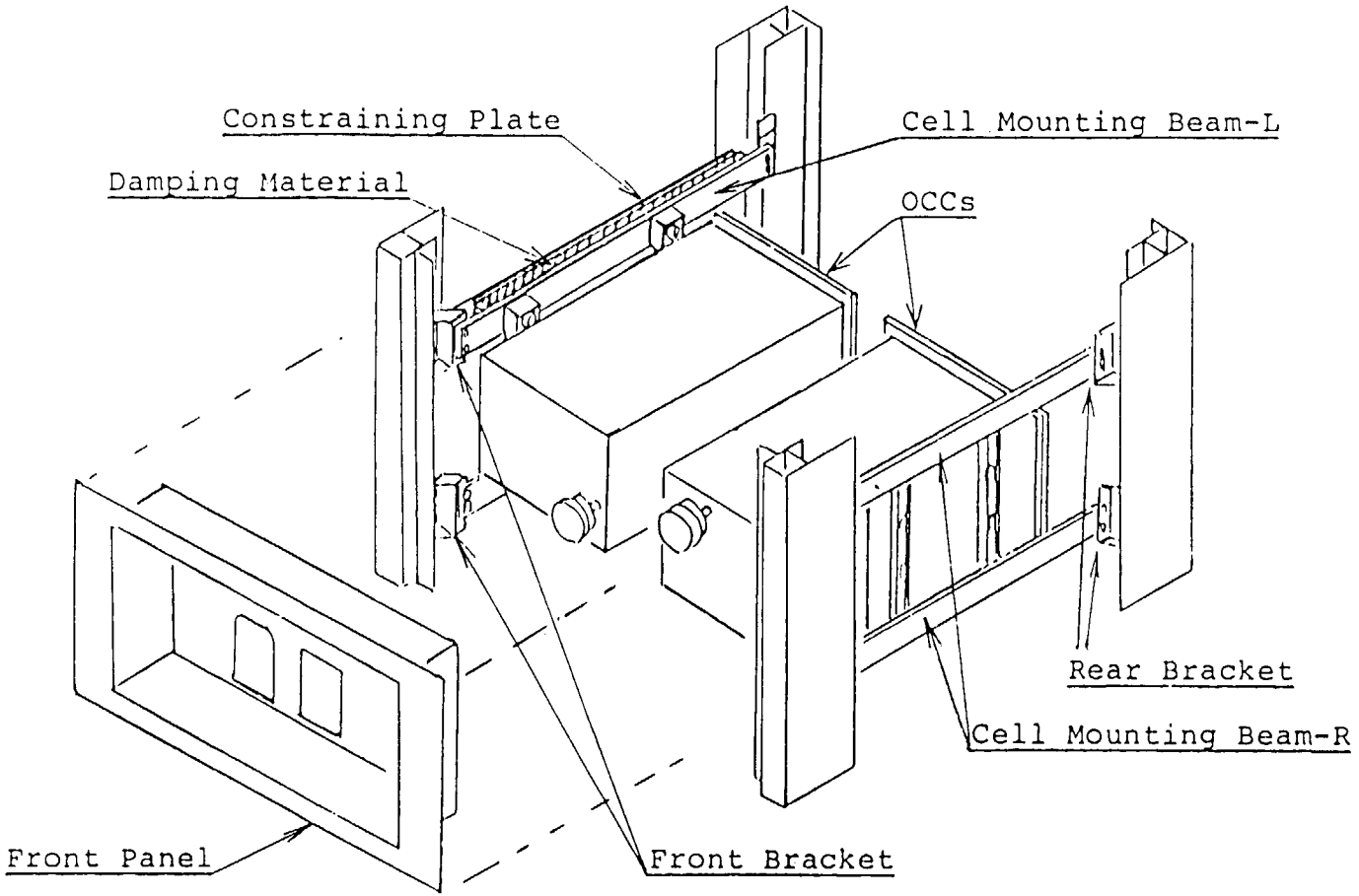

Figure 1. Organic Crystal Growth Facility Concept.

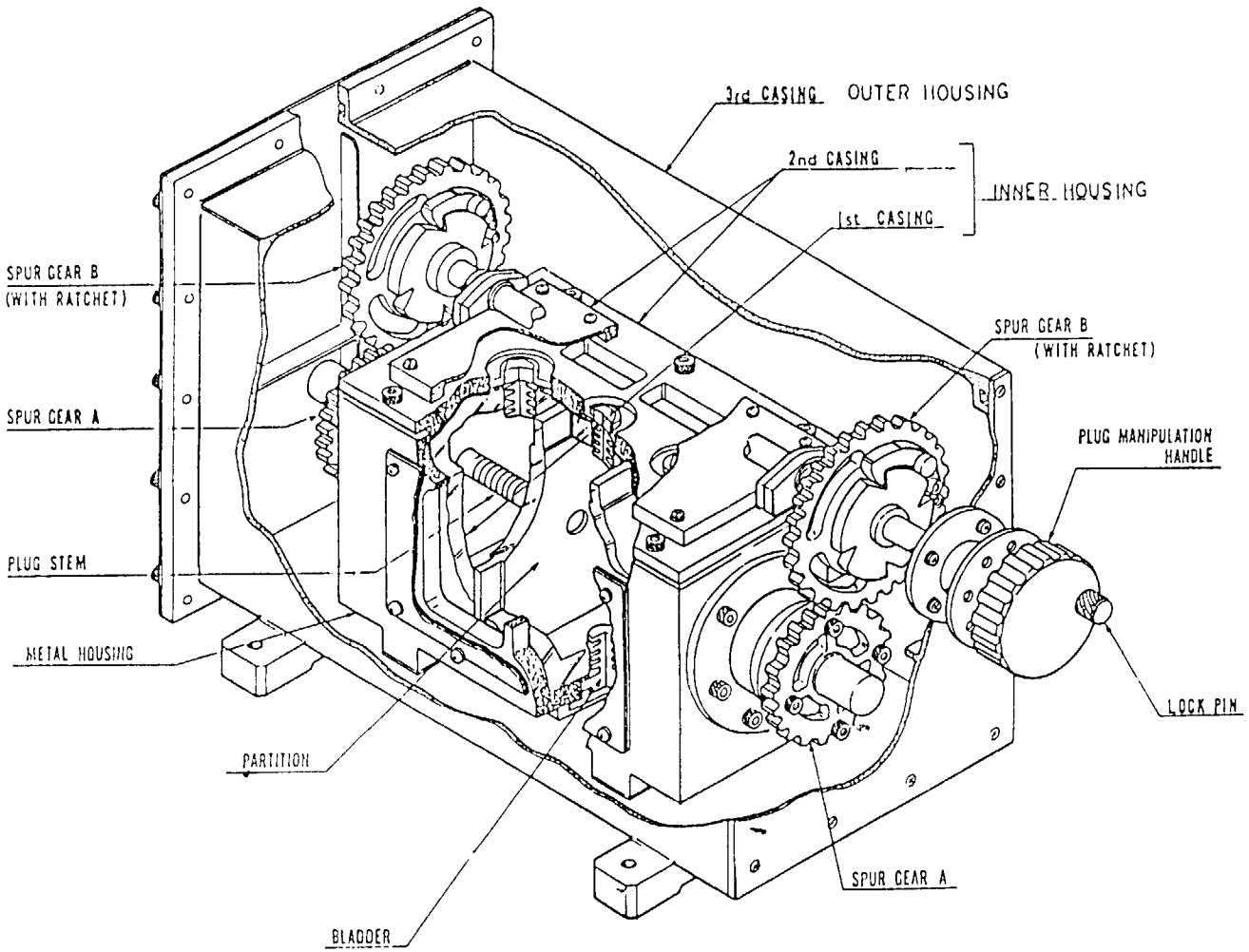

Figure 2a. Organic Crystal Growth Cell Concept.

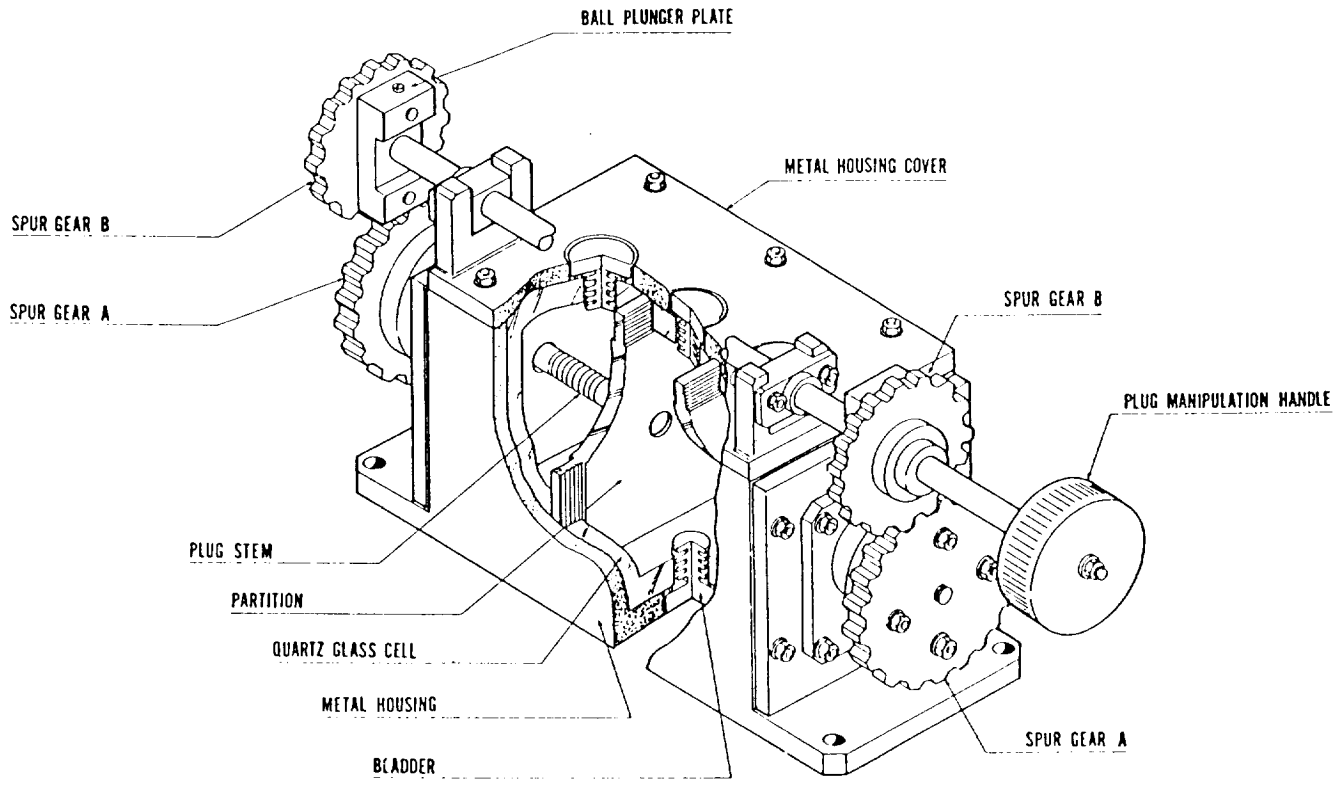

Figure 2b. Organic Crystal Growth Cell Flight Model.