Rotating Vessels for Growing Protein Crystals

Rotation would ameliorate adverse effects of gravitation.

Lyndon B. Johnson Space Center, Houston, Texas

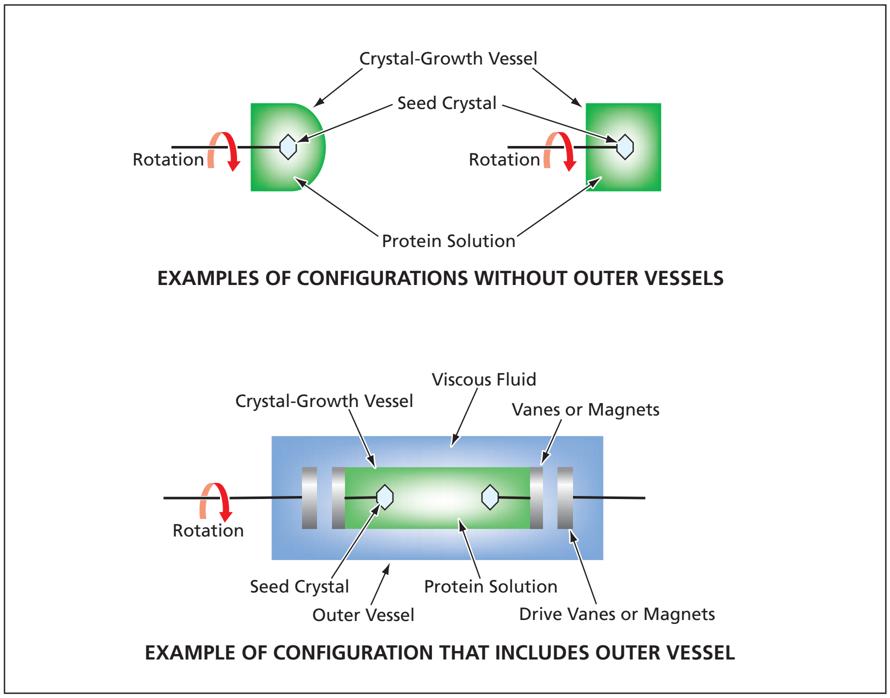
Rotating vessels have been proposed as means of growing larger, more nearly uniform protein crystals than would otherwise be possible in the presence of normal Earth gravitation. Heretofore, nonrotating vessels have been used.

It is difficult to grow high-quality protein crystals in the terrestrial gravitational field because of convection plumes created by the interaction between gravitation and density gradients in protein-solution depletion layers around growing crystals. The density gradients and the associated convection plumes cause the surfaces of growing crystals to be exposed to nonuniform solution densities, thereby causing the crystals to form in irregular shapes. The microgravitational environment of outer space has been utilized to eliminate gravitation-induced convection, but this approach is generally not favorable because of the high cost and limited availability of space flight.

The use of a rotating vessel according to the proposal is intended to ameliorate the effects of gravitation and the resultant convection, relative to the corresponding effects in a non-rotating vessel. The rotation would exert an averaging effect over time, distributing the convective force on the depletion layer. Therefore, the depletion layer would be more nearly uniform and, as a result, the growing crystal would be more nearly perfect.

The proposal admits of variations (see figure), including the following:

- The growing crystal could be rotated about its own central axis or an external axis.
- The crystal-growth vessel could be of any of various shapes, including cylindrical, hemispherical, conical, and combinations thereof.
- The crystal-growth vessel could be suspended in a viscous fluid in an outer vessel to isolate the growing crystal from both ambient vibrations and vibrations induced by a mechanism that drives the rotation.
- The rotation could be coupled to the crystal-growth vessel by viscous or magnetic means.
- The crystal-growth vessel could be supported within the outer vessel by use of a magnetic field.
- The crystal-growth vessel and the outer vessel could be configured in a variety of ways to facilitate heat transfer, instrumentation, and rotation.



A **Hinged Pair of Mechanically Biased Bimorphs** constitutes a unit-cell piezoelectric actuator that can generate a positive or negative displacement. Unit cells can be stacked to obtain a greater stroke.

This work was done by Paul Cottingham of Wyle Laboratories for **Johnson Space Center**. *For further information, contact the Johnson Technology Transfer Office at (281) 483-3809.*

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Oscillating-Linear-Drive Vacuum Compressor for CO_2

Lyndon B. Johnson Space Center, Houston, Texas

A vacuum compressor has been designed to compress CO_2 from ≈1 psia (≈6.9 kPa absolute pressure) to ≈75 psia (≈0.52 MPa), to be insensitive to moisture, to have a long operational life, and to be lightweight, compact, and efficient. The compressor consists mainly of (1) a compression head that includes hydraulic diaphragms, a gas-compression diaphragm, and check valves; and (2) oscillating linear drive that includes a linear motor and a drive spring, through which compression force is applied to the hydraulic diaphragms. The motor is driven at the resonance vibrational frequency of the motor/spring/compression-head system, the compression head acting as a damper that takes energy out of the oscillation. The net effect of the oscillation is to cause cyclic expansion and contraction of the gas-compression