Why Space? Space Biotechnology Research

BIOPROCESSING RESEARCH IN LOW GRAVITY AND THE TECHNICAL SUPPORT INDUSTRY

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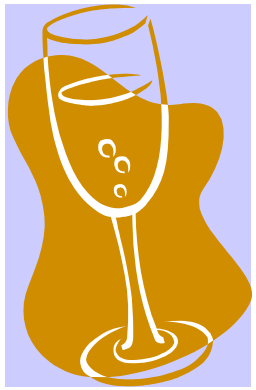
SUBJECTS TO BE COVERED

- What can be learned from research in low gravity – “Microgravity”?
- Electrophoresis technology on Earth
- Microencapsulation by electrophoresis
- Polymeric thin films for quality semipermeable membranes
- The space technology support industry

GRAVITY DEPENDENT PROCESSES



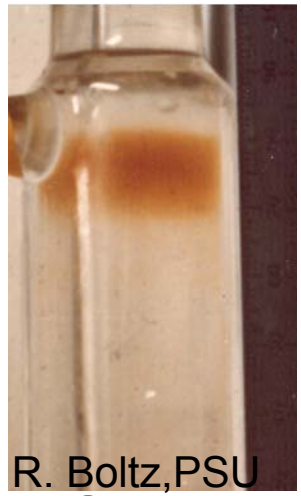
Bubbles Rising

R. Brown, BioServe

Bacteria Metabolizing

R. Kroes NASA

Crystals Growing



R. Boltz,PSU

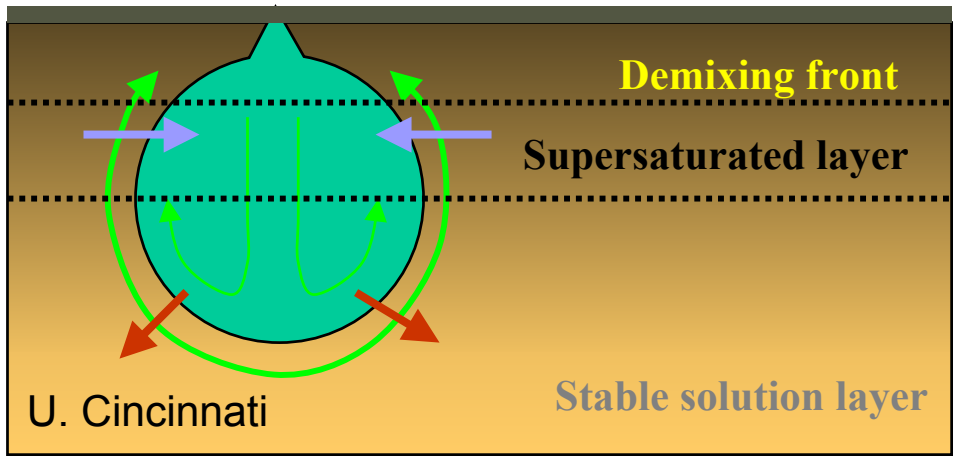
Cells Falling

Plants Growing

Humans Aging

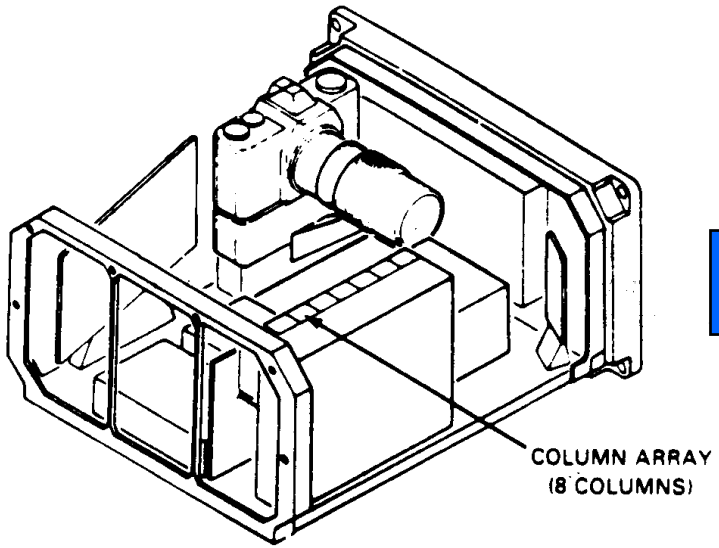
WHAT HAPPENS TO THESE PROCESSES IN A LOW-GRAVITY ENVIRONMENT?

- Surface tension exceeds hydrostatic pressure
- Drops or bubbles of light (warm) fluids don't rise
- Suspended particles (cells) don't sediment
- Surface forces and fluid stresses get a chance to overwhelm inertial forces (gravity)

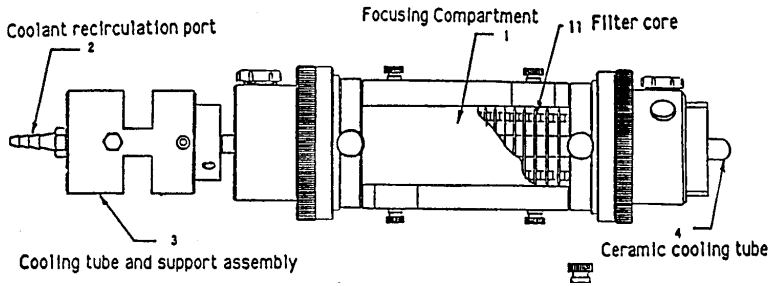


LOW-GRAVITY ELECTROPHORESIS RESEARCH COMMERCIAL OUTCOMES

Isoelectric focusing: Experiments by Bier and Snyder. Separator now being sold by Bio-Rad.



Snyder, Bier, NASA



Bier et al., U. of Arizona, ACS

LOW-GRAVITY ELECTROPHORESIS RESEARCH COMMERCIAL OUTCOMES

Free Flow Electrophoresis: Experiments by McDonnell Douglas, Snyder and Rhodes. Separator now being sold by Tecan.

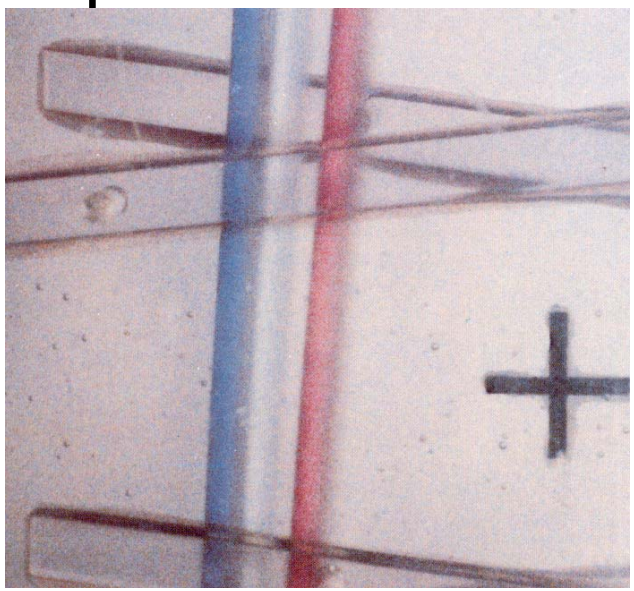
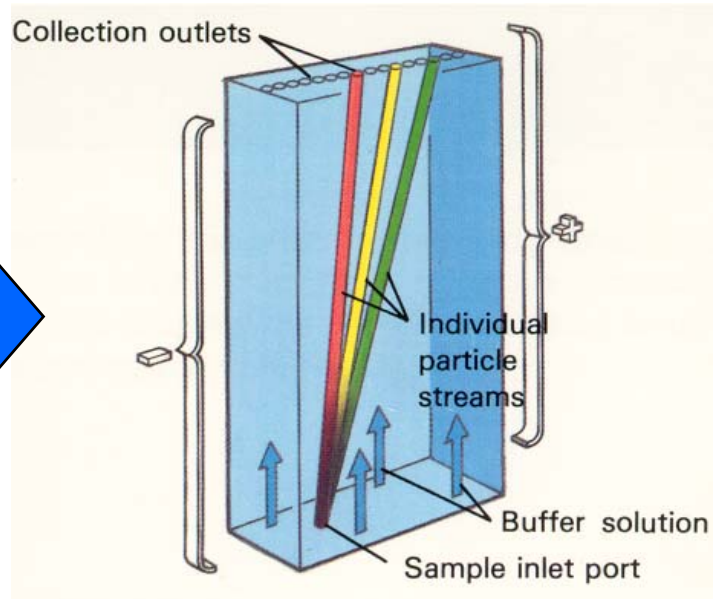


Photo:Snyder et al., NASA



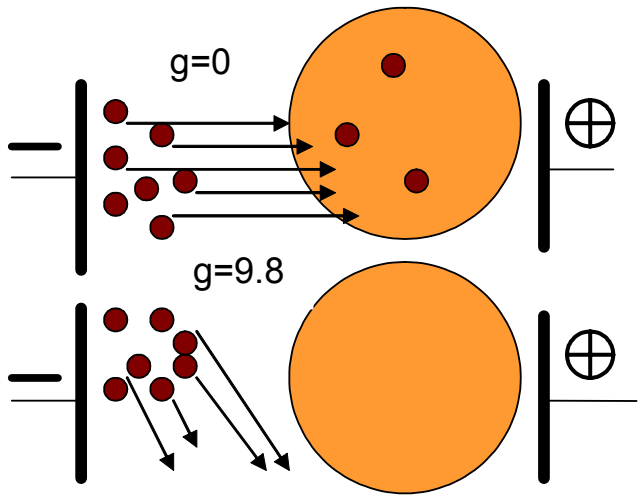
McDonnell Douglas

MICROENCAPSULATION BY ELECTROPHORESIS

Microcapsules for control of time and site of drug delivery, plus radio-diagnostic dosimetry.

- **Several flights of MEPS: Dr. Dennis Morrison (NASA), Institute for Research and ITA. Investment interest.**
- **Gravity-sensitive process; very different settling rates of components**

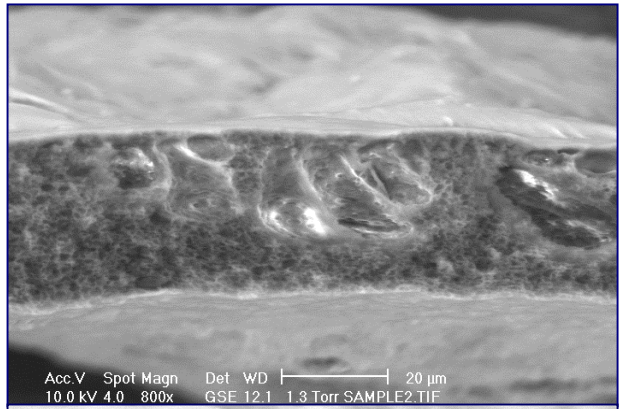
D. Morrison, NASA



POLYMER THIN FILMS FOR QUALITY SEMIPERMEABLE MEMBRANES

- $3 B industry worldwide
- Formation of macrovoids not controlled because it's not understood.
- Two possible causes, one controllable and one not
- Low-g experiments on aircraft demonstrate controllable cause.
- Microcapsules for control of time and site of drug delivery, plus radio-diagnostic dosimetry.

H. Lee, U. of Cincinnati



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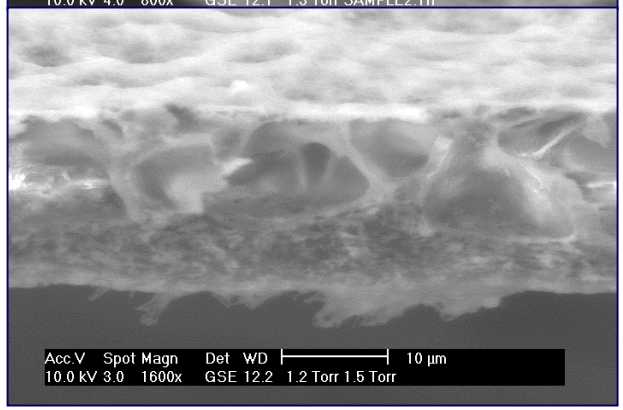

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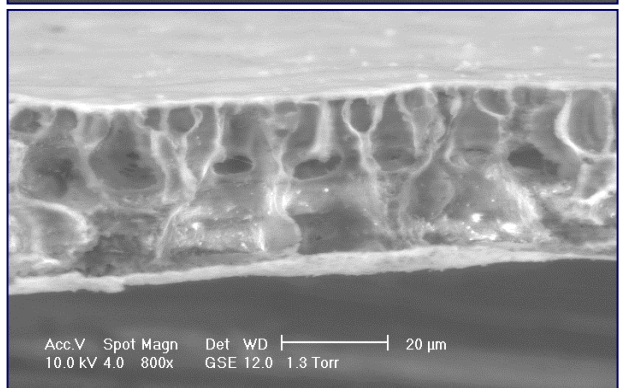

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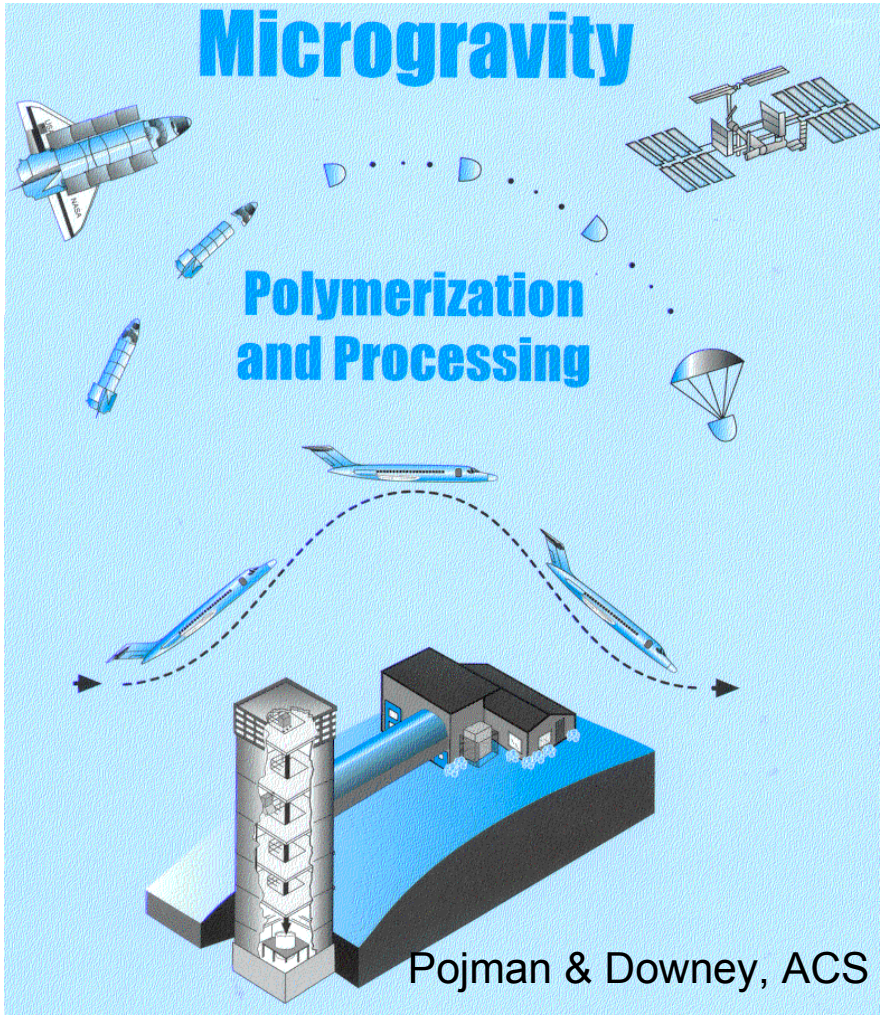
FACILITATORS OF COMMERCIAL USE OF LOW GRAVITY

PRIVATE-SECTOR HARDWARE AND SERVICE PROVIDERS

- Instrumentation Technology Associates, Exton, PA
- New Century Pharmaceuticals, Huntsville, AL
- Orbital Technology Corp., Madison, Wisconsin
- Paragon Space Technologies, Tucson, AZ
- Payload Systems, Inc., Cambridge, MA
- Space Hardware Optimization Technology (SHOT), Greenville, IN

LOW-GRAVITY FACILITIES

- Drop Towers (1-10 sec)
- Low-gravity aircraft (10-20 sec)
- Sounding Rockets (6-16 min)
- Space Shuttle (10-16 days)
- ISS (3-30 mo)
- Orbital Free Flyers (3-300 days)



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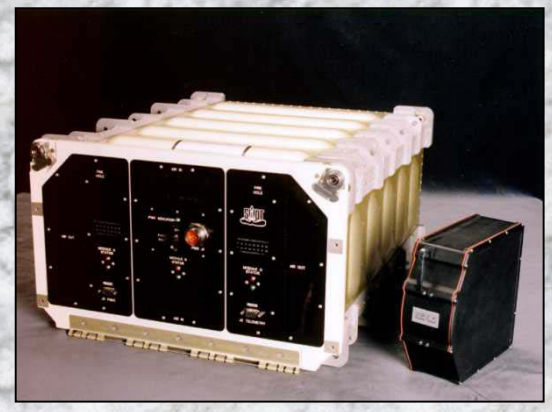
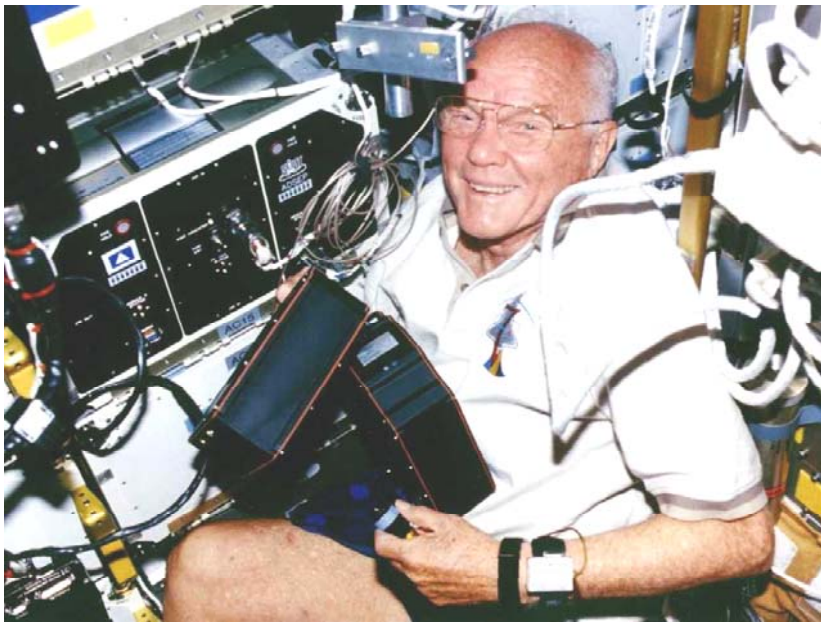
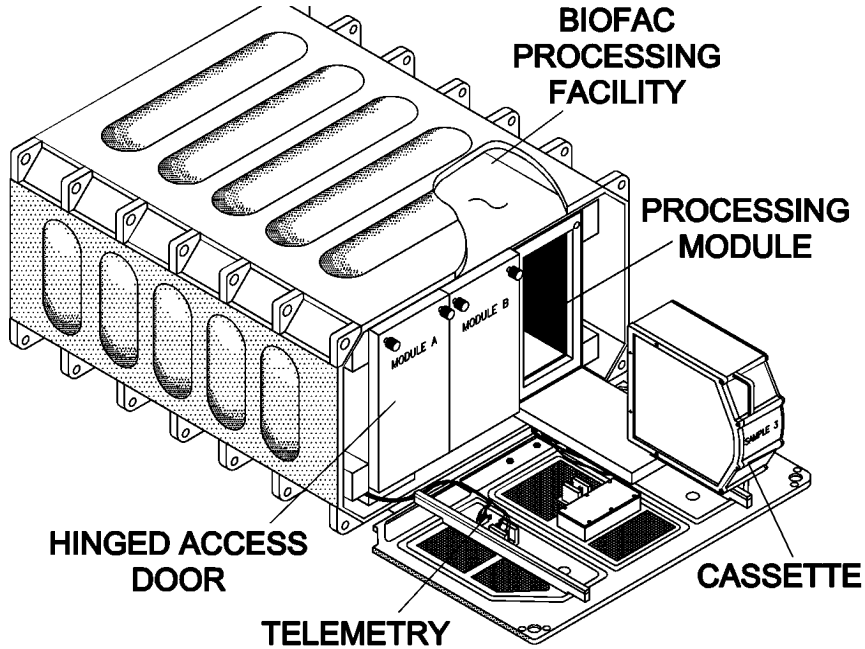
- **Founded in 1988, Space Hardware Optimization Technology, Inc., (SHOT) is an applied-technology company providing engineering services and equipment to customers performing research both in space and in their ground-based laboratories.**



PLANS FOR PROCESSING FACILITIES FOR CASSETTES ON ISS





"ADSEP" 3-Cassette Processing Facility on STS-95
Cassettes to fly on Shuttle; Facility to remain on ISS
www.shot.com