Dual Materials Dispersion Apparatus (DMDA)

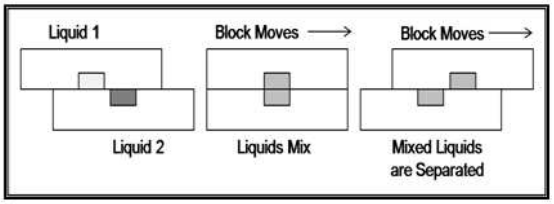
BioSpace Experiments, Inc.™ (BSE) is offering a unique opportunity to fly microgravity experiments using our DMDA flight qualified hardware on the SpaceX Dragon through NanoRacks LLC. The flight date is expected to be 3rd Qtr 2013. BSE's Dual Material Dispersion Apparatus (DMDA) is our most advanced mini-lab that increases the data point capacity of the MDA and adds flexibility and versatility to the types of experiments conducted. The DMDA hardware utilizes the same sliding block technology as the MDA. A single DMDA contains two sets of sample blocks capable of accommodating a total of ~300 samples with two different science protocols. The DMDA sliding block mechanism is housed in an aircraft aluminum housing which acts as a pressure vessel with a sealed internal compartment where biomedical experiments are conducted while on orbit. All experiments are performed with two levels of containment within the DMDA housing. Should a third level be required, a Lexan containment vessel is available to provide this additional level. The DMDA also comes with an option to fly a camera to monitor experiments in nine sample wells. This hardware is called the DMDA-O for optical. Additionally, 100 conventional wells are available for experiments.

Astronaut Story Musgrave operating The DMDA aboard STS-80

The DMDA space processing hardware has redundancy and can be activated autonomously via an electrical command, or timer/G switch or with an onboard controller operated by the crew to initiate and terminate the experiment; in addition, the hardware has a fail safe feature consisting of a manual over-ride capability operated by a crew member. Options are being explored to add a controlled temperature enviroment and is expected to be available in the 3rd Qtr 2013.

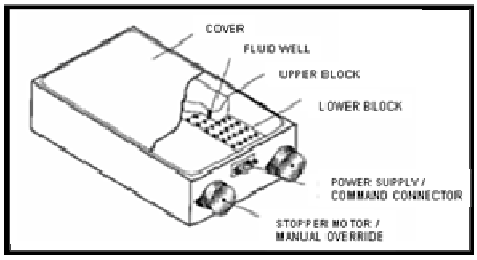
DMDA Capabilities

Principle of Block Operation for Mixing Fluids within the DMDA



Research Supported:
The DMDA multi-user mini-lab can accommodate a broad range of microgravity experiments including cell biology, thin film membrane casting, protein crystal growth, seed germination, collagen research, fluid sciences and diffusion experiments, microencapsulation of drugs, inorganic crystal growth and more.

Standard DMDA Schematic



Mixing Methods:
Up to seven mixing methods are available in the DMDA: liquid-to-liquid diffusion, osmotic dewatering (analogous to vapor diffusion), magnetic mixing, step gradient diffusion, reverse step gradient diffusion, combined strep gradient and osmotic de-watering and combined magnetic mixing and step gradient diffusion. The experimenter has the option to incorporate any one of these techniques, or a combination of them, within the limits of his or her science protocol.

Protocol Flexibility:
The DMDA hardware has two independent sets of sample blocks which can be activated or deactivated upon command to meet divergent

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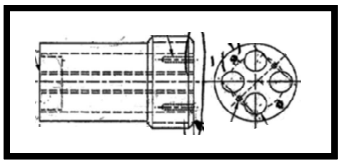
science community requirements (i.e. crystal growth or biologic research). This means that **two independent science protocols are available for researchers**.

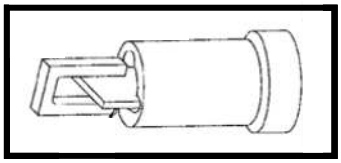
Data Yield:
The DMDA multi-user mini-lab can accommodate a broad range of microgravity experimentation. Ideally suited for protein crystal growth, depending upon the specific crystal growth techniques utilized, up to 300 data samples can be obtained in a single DMDA unit. However, the DMDA also has the capability to increase its sample capacity from 300 to 400+ through the addition of capillary inserts, and the option for capillary tube inserts for protein growth capability.

Crystal Growth:
An additional removable well option provides for both organic (protein) crystal growth and inorganic crystal growth using the capillary technique, which has been shown to produce very large protein crystals in microgravity. Four capillary tubes containing the same or different protein and salt solutions are affixed in a removable bottom well. This technique has the advantage of emulating the LMA hardware, which has been shown to produce exceptional protein crystal results during space flight, and the samples can be quickly harvested as depicted.

Well Insert with Four Capillary Tubes



Reconfigured DMDA Well with Glass Cover slip



Cell/Biological Research:
Many scientists engaged in cell biology find it advantageous to utilize glass cover slips in their experiments. Accordingly, we have recently modified the design of a portion of DMDA wells to accept glass cover slips as depicted.

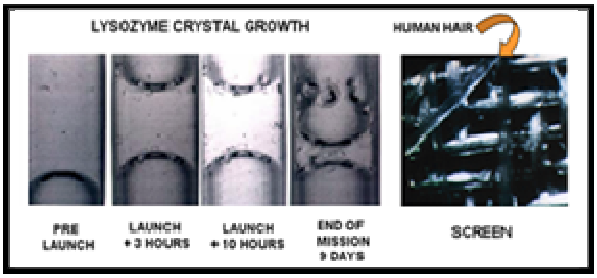
Removable Wells:
The DMDA hardware also has an option for removable (easily extractible) bottom wells to enable the expedited harvesting of samples to preclude the normal longer post-flight sample extraction process if required.

DMDA Mission Specifications

- **Number of Data Samples Available**
  - Up to 300 0.125 inch Experiment wells/data points
  - Each well can contain up to 125 microliters (µl) of fluid.
  - The top block is fixed at 125 µl per well.
  - Bottom block can be varied from 25 to 125 µl per well.
  - Well diameters can be increased to 0.25 inches providing 500 µl per well with a corresponding decrease in the number of wells.
- **Dimensions & Weight**
  - 2.4" x 5.78" x 14.5" Weight = 7.2 lbs
- **Temperature Control**
  - ISS shirt sleeve environment: 18°-27°C (64°- 81°F) (No temperature control)
  - 6°C and 20°C (with temperature control)
  - 20º C and 37º C (with temperature control)
- **Power Requirements**
  - DMDA 0 watts (without temperature control)
  - DMDA: 110 watts (with temperature control)
- **Flight History**
  - STS-80: CMIX-5 in1996, STS-86: CAPE-1 in 1997. STS-95: CIBX-1 in 1998, STS-107: CIBX-2 in 2003

2nd Generation DMDA & DMDA-O with Controller Flown on Shuttle and Mir

DMDA-O 150X Video Capability



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