Advanced Colloids Experiment – Electric field (ACE-E)

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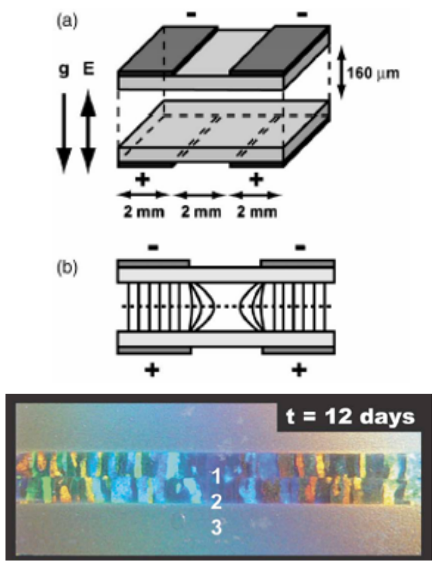

Electric bottle and colloidal crystal

Objective:

- To remove gravitational jamming and sedimentation so that it is possible to observe how order arises out of disorder and to learn to control this process. Small colloidal particles can be used to model atomic systems and to engineer new systems. Colloids are big enough (in comparison to atoms) to be seen and big enough and consequently slow enough that their evolution can be recorded with a camera. With a confocal microscope and specialty cells, we can observe this process in 3D and learn to control it. Applying an electric field to specially engineered colloidal particles will enable science teams to bring active control of micron-sized particles to colloidal engineering and self assembly.

Relevance / Impact:

- Chaikin (NYU): ACE-E1 involves the combined use of microgravity, microscopy and electric fields to study the assembly, structure, dynamics and activation of complex colloidal and emulsions systems. A goal of the present study is to mimic both nature and industry in developing processes, using different forces, here primarily electric, to make complex functional materials and devices rather than having them assemble in an uncontrolled manner.
- Khusid (NJIT): ACE-E2 will emphasize the electric field-driven evolution of phase transitions, electro-hydrodynamic instabilities and formation of crystalline structures in colloids. Colloidal assembly provides the capability for scalable manufacturing of structured materials and devices for industries.
- Marr (CSM): ACE-E3 will explore the assembly behavior, along with the folding and network formation of linear colloidal chains, colloidal spheres, and asymmetric dimers. Such structures will generally lead to arrays with reduced symmetry and enhanced directionality that can interact with a broad range of electromagnetic radiation in unique ways and have potential as next-generation functional materials.
- Williams (U. Louisville): ACE-E4 involves the electrokinetic self-assembly of complex 3D structures resulting from the interaction of different sized particles suspended within a fluid medium, vital to the design of advanced materials.

Development Approach:

- Incremental development approach: ACE-M (basic Microscopy of discrete samples), ACE-T provides sample cells that control Temperature and in-situ mixing. Full 3D imaging becomes available with confocal microscopy, which takes a series of high magnification slices of (fluorescently tagged) samples and assembles them to produce a clear high-resolution 3D image. The addition of electric fields moves colloidal engineering from passive observation to the active manipulation of 3D structures on ISS.

ISS Resource Requirements

Accommodation (carrier)	Light Microscopy Module (LMM)
Upmass (kg) (w/o packing factor)	3.5 kg / ACE-E base 4.0 kg Control Module
Volume (m^3) (w/o packing factor)	0.001 m^3 ACE T Base 0.003 m^3 Control Module
Power (kw) (peak)	0.012kw ACE-T, 1.1 kw FIR / LMM
Crew Time (hrs) (installation/operations)	2.5 - 3.5 per installation
Launch / Increment	SpaceX-16-17 / Increment 55-60