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ADVANCEMENTS IN MICROSCOPIC OBSERVATION TECHNOLOGY FOR SPACE BIOLOGICAL EXPERIMENTS

Abstract

The International Space Station (ISS) has long been a hub for bio-experiments in microgravity, but challenges such as human error, labor costs, and experiment restrictions have prompted a shift towards artificial satellite-based missions. Researchers are exploring bio-experimental missions to be conducted via satellites, aiming to automate procedures and reduce human intervention. This shift becomes more crucial with the retirement of the ISS, expecting an increase in satellite-based bio-experiments.

To facilitate this transition, IDDK is collaborating with satellite manufacturers to streamline the development of bio-experimental equipment and artificial satellites. Its focus lies in microscopic observation, a vital aspect of bio-experiments, and introduces the micro imaging device (MID) technology to address challenges related to weight, vibration, and space availability.

MID technology revolutionizes traditional microscopy by utilizing semiconductor-based systems. Unlike conventional microscopes, MID requires no optical magnification, eliminating the need for individual adjustments of the optical lens system. This ensures a resolution dependent on the size of the semiconductor mesh, providing a lightweight and ultra-compact solution for microscopic observation.

In a microscopic observation method using MID, the specimen is placed on the surface (or placement unit set as necessary) of an MID imaging area (imaging device array) and is illuminated. The light information from the specimen is then directly collected in the MID. In MID, multiple pixels, including an optical element that collects light and a light receiving unit (photodiode) that receives the light collected by the optical element, are arranged at predetermined intervals. This method requires no optical magnification, and hence images can be acquired with a resolution dependent on the size of the semiconductor mesh without loss of light information due to the optical path. Therefore, unlike conventional microscopes, no individual adjustment is required for the optical lens system to form an image of light from the object of interest at the desired position and magnification.

The MID technology's versatility is demonstrated through sample images, showcasing the ease of capturing microscopic images without the need for focusing. The images include zooplankton and lysozyme crystals, highlighting the technology's capabilities in observing dynamic samples.

Moving forward, IDDK is developing a Micro Bio Space Lab, a compact system for real-time microscopic observation of cultured cells or microorganisms in space. This lab aims to provide an integrated solution, incorporating environmental sensors and a solution tank for various applications, including cell culture.