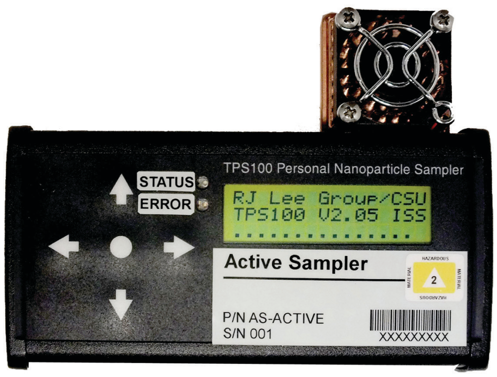
TPS100 Nanoparticle Sampler

RJ Lee Group Reaches the Final Frontier

Our understanding of the living conditions astronauts experience in the International Space Station (ISS) may be colored by our exposure to science fiction. Based on this experience, you might assume that an unknown airborne substance in a spacecraft was of alien origin, seeping in by accident or on purpose. In reality, particulate in the air of the ISS is generated mostly by the activities of humans and mechanical devices. The cabin air quality is obviously critical to the health and well-being of the crew and the equipment, and thus understanding the quantity and nature of particulate matter is paramount not only for ISS crew members, but also for future long-term missions such as the Journey to Mars. In spite of high-efficiency filtration systems on the ISS, the astronauts have reported itchy eyes and other allergy-type symptoms, and NASA experts suspect the issues are caused by particulate in the air.

How Are We Sampling Particles in Space?

Enter the TPS100 Nanoparticle Sampler. The TPS100 is a compact, microcontroller-based sampling device that uses thermophoresis to deposit nanoparticles directly on an electron microscope (EM) grid. Thermophoresis is particle movement induced by a thermal gradient. The TPS100 uses a temperature gradient across a narrow sampling channel to capture airborne particles on the grid. The technology is especially effective for capturing nanoparticles – a thousand such particles laid side-by-side would roughly equal the width of a human hair. By virtue of the sampling process, nanoparticles collected by the TPS100 are highly visible compared to other sampling approaches such as filter based methods in which the nanoparticles can be masked by larger particles or by the sampling media itself. The TPS100 attracted the attention of NASA, who will now be using the sampler in slightly modified form – dubbed Active Aerosol Sampler (AAS) – to help quantify airborne particles in the ISS.



Nanoparticle Sampler modified for NASA as the Active Aerosol Sampler.

Meeting NASA Requirements

As RJ Lee Group looked to this new frontier, the TPS100 would need to undergo a stringent vetting process to gain NASA approval for flight. While passing muster successfully for a variety of electrical, electromagnetic, and mechanical requirements, the TPS100 required modifications to meet the ISS touch-temperature requirements. To generate thermophoresis, the TPS100 must dissipate heat through natural convection – not a problem on Earth, where warm air rises and carries heat away from the unit. In the microgravity environment on the ISS, however, there is very little natural convection. So the team went back to the drawing board and added a special forced-air cooling plate. Lab testing at RJ Lee Group with the TPS100 packed in insulating material – to simulate the worst-case thermal conditions in microgravity – proved the modifications were successful, and the AAS was born.

Following approval by NASA, RJ Lee Group supplied two AAS units to NASA for launch to the ISS. While on the ISS, eight to ten separate multi-hour sampling sessions will be performed in different ISS locations to collect nanoparticulate during activities such as cleaning and use of exercise equipment, as well as opening the hatch after a cargo vehicle docks.

Enter the Passive Aerosol Sampler

Since the AAS focuses almost exclusively on nanoparticles, the RJ Lee Group team worked with Mr. Miller-Lionberg again to meet Dr. Meyer's need to collect larger particles as well. This is important because, per Dr. Meyer, "We take it for granted, but on Earth, gravity cleans our air quite nicely. In space, cookie crumbs don't fall down, they float around and move with the air flow in the spacecraft cabin." The result was the modified passive aerosol sampler (PAS), a device based on the University of North Carolina passive sampling technology developed by Jeff Wagner and David Leith. The PAS was designed with five small, drawer-like sampling chambers that will be used to collect particulate on ISS air vents for durations of 2, 4, 8, 16, and 32 days. Seven PAS and two AAS units will be utilized in this this space experiment, to provide a profile of particles across a wide range of size, time, and locale.

Passive Aerosol Sampler with Drawers Extended.

Sample Analysis

Upon return to Earth, the AAS cartridge keys along with the PAS samples will be analyzed using a variety of light, laser and electron microscopy techniques. Collecting particulate on the ISS using the AAS and PAS will provide a wealth of information on particle characteristics on the ISS. In the words of Dr. Meyer, "The goal of this experiment is data collection. If we know the characteristics of the airborne particles on ISS, it will help us choose or design an appropriate particulate matter monitor for use on ISS and future space missions."

From the data generated, NASA will learn about the true nature of airborne particulate in the ISS – and thus begin to separate science facts from science fiction.

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