

## The microbe capture experiment in space: Fluorescence microscopic detection of microbes captured by aerogel

Tomohiro Sugino<sup>1\*</sup>, Shin-ichi Yokobori<sup>1</sup>, Yinjie Yang<sup>1</sup>, yuko Kawaguchi<sup>1</sup>, Hirofumi Hashimoto<sup>3</sup>, Kyoko Okudaira<sup>4</sup>, Makoto Tabata<sup>3</sup>, Hideyuki Kawai<sup>5</sup>, Yoshitaka Yoshimura<sup>6</sup>, Issay Narumi<sup>7</sup>, Norihiro Hayashi<sup>8</sup>, Hajime Yano<sup>3</sup>, Masamichi Yamashita<sup>3</sup>, Kensei Kobayashi<sup>2</sup>, Akihiko Yamagishi<sup>1</sup>

<sup>1</sup>Tokyo Univ. Pharm. Life Sci., <sup>2</sup>Yokohama Natl. Univ., <sup>3</sup>JAXA, <sup>4</sup>Univ. Aizu, <sup>5</sup>Chiba Univ., <sup>6</sup>Tamagawa Univ., <sup>7</sup>JAEA, <sup>8</sup>Tokyo Inst. Tech.

Microbes have been collected at the altitude up to about 70 km in the sampling experiment done by several groups<sup>[1]</sup>. We have also collected high altitude microbes, by using an airplane and balloons<sup>[2][3][4][5]</sup>. We collected new deinococcal strain (*Deinococcus aetherius* and *Deinococcus aerius*) and several strains of spore-forming bacilli from stratosphere<sup>[2][4][5]</sup>. On the other hand, Panspermia hypothesis, where terrestrial life is originated from outside of Earth, has been proposed<sup>[6][7]</sup>. Recent report suggesting existence of the possible microbe fossils in the meteorite of Mars origin opened the serious debate on the possibility of migration of life embedded in meteorites (and cosmic dusts)<sup>[8][9]</sup>. If we were able to find terrestrial microbes in space, it would endorse the possibility that the terrestrial life can travel between astronomical bodies.

We proposed a mission Tanpopo: Astrobiology Exposure and Micrometeoroid Capture Experiments to examine possible interplanetary migration of microbes, organic compounds and meteoroids on Japan Experimental Module of the International Space Station (ISS)<sup>[10]</sup>. Two of six sub themes in this mission are directly related to interplanetary migration of microbes. One is the direct capturing experiment of microbes (probably within the particles of clay) in space by the exposed ultra-low density aerogel. Another is the exposure experiment to examine survivability of the microbes in harsh space environment. They will tell us the possibility of interplanetary migration of microbes (life) from Earth to outside of Earth (or vice versa).

In this report, we will report whether aerogel that have been used for the collection of space debris and cosmic dusts can be used for microbe sampling in space. We will discuss how captured particles by aerogel can be detected with DNA-specific fluorescence dye, and how to distinguish microbes from other materials (i.e. aerogel and particles such as clay). The surface of micro-particles captured by aerogel is often vitrified. The non-specific fluorescent light is often observed from vitrified materials. Therefore, we need to distinguish fluorescent light of stained microbes from that of spectral characteristics of vitrified materials and bleaching rate are going to be need to distinguish stained microbes with DNA-specific fluorescence dye and other materials such as clay and aerogel. Fluorescence of stained microbes showed attenuation faster than that of vitrified materials. Fluorescence of vitrified materials showed broader spectra than that of stained microbes. We simulated the high-speed collision of micro-particles to the aerogel with the two stage light gas gun (ca. 4 km/s). The micro-particles containing pre-stained and dried cells of *Deinococcus radiodurans* mixed with clay material were used for the collision experiment, and the captured particles were observed with a fluorescence microscope. This experiment suggests that the captured microbes can be detected and be distinguished from clay materials.

### Reference

[1] Yang, Y. et al. (2009) *Biol. Sci. Space*, 23, 151-163. [2] Yang, Y., et al. (2008) *Biol. Sci. Space* 22:18-25. [3] Yang, Y., et al. (2008) JAXA-RR-08-001: 34-42. [4] Yang, Y., et al. (2009) *Internatl.*

J. Syst. Evol. Bacteriol., 59: 1862-1866. [5] Yang, Y. et al. (2010) Internatl. J. Syst. Evol. Bacteriol. (in press). [6] Arrhenius, S. (1908) Worlds in the Making-the Evolution of the Universe (translation to English by H. Borns) Harper and Brothers Publishers, New York. [7] Crick, F. (1981) Life Itself. Simon & Schuster, New York. [8] Chyba, C. and C. Sagan (1992) Nature 355: 125-132. [9] Sandford, S. A., et al. (2006) Science 314: 1720-1724. [10] Yamagishi, A., et al. (2008) International Symposium on Space Technology and Science (ISTS) Web Paper Archives. 2008-k-05.

Keywords: microbe capture experiment, DNA-specific fluorescence dye, the International Space Station