LIFE DETECTION MICROSCOPE FOR VENUS CLOUD PARTICLE INVESTIGATION. S. Sasaki[1], Y. Yoshimura[2], A. Miyakawa[3], K. Fujita[4], T. Usui[4], S. Ohno[5] , A. Yamagishi[3] and S.S. Limaye[6], [1]Tokyo University of Technology, 5-23-22 Nishikamata, Ohta-ku, Tokyo 144-8535 JAPAN, [2]Tamagawa University, 6-6-1 Tamagawa Gakuen, Machida, 194-8610 Japan, [3]Tokyo University of Pharmacy and Life Sciences, 1432-1 Horinouchi, Hachioji, 192-0392 Japan, [4]JAXA, 3-1-1 Yoshinodai, Chuo-ku, Sagamihara, 252-5210 Japan, [5]Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino 275-0016 Japan, [6]University of Wisconsin, 1225 W. Dayton St, Madison, WI 53706, USA.

Venus clouds consist of droplets of 75-85% sulfuric acidic-water. However, sulfuric acid is not sufficient to explain the observed cloud contrasts and albedo of the planet [1], requiring other chemical species involved in absorption [2]. Active volcanos are expected on current Venus [3]. Based on the possible existence of the past liquid water, evolution and emergence of sulfur-metabolizing or thermophilic bacteria have been postulated [4]. Though surface of current Venus may be hostile to organic compound and living organism, there is area with moderate temperature and pressure several tens kms above surface on Venus. Limaye et al [4] have postulated the presence of microorganisms in the clouds, contributing to the spectroscopic characteristics. To distinguish biological aerosols from abiotic ones, missions with aerial platforms equipped with life detection instruments would be effective [4].

Life Detection Microscope (LDM) is well-suited for this purpose. LDM is designed to search for possible "cells" in the samples. LDM will be able to get high-resolution visible images of particles with 1 μm/pixel resolution. To distinguish biotic organic compounds from abiotic, LDM is equipped with an originally designed pigment system. Observation of biotic organic compounds surrounded by membrane is also feasible by the system [5]. The LDM detects life as particles carrying organic compounds characteristics of terrestrial life. Life on Earth utilizes organic compounds to sustain itself. The compounds are separated by an envelope, so-called membrane, from their environment so that variations in the external conditions would least affect their function. In definition, organic compounds surrounded by membrane ("cells") are the fundamental framework for terrestrial life. Organic compounds in a cell thus possess the catalytic activities to generate free energy to survive. Although no one knows yet what life on Venus clouds look like, as our biology stands on the dogma that all the terrestrial life has cells as the building block, it would be reasonable to apply the similar recognition for Venus life. With such assumption of life, LDM is capable of detecting and characterizing organic compounds by using a combination of fluorescent dyes, which is widely used in the field of biology.

Combination of fluorescent dyes will enable the detection of various compounds; i.e., those of abiotic origin such as polycyclic aromatic hydrocarbon (PAH), biotic organic compound seen inside cells such as DNA, RNA and proteins, or biotic organic compound surrounded by membrane. In addition, the product of catalytic activity will also be detected. Our microscope is, therefore, capable of identifying what we think to be the most fundamental features that a cell should have to maintain life, organic compounds surrounded by membrane having catalytic activity. In case of Mars LDM, in specific, fluorescence dyes named SYPRO Red, SYTO 24, propidium iodide and CFDA-AM will be used for these purposes, respectively. SYPRO Red can stain both PAH and protenoid. SYTO 24 can stain organic molecules inside cells irrespective of their state, dead or alive. Propidium iodide, on the other hand, stains only the dead cells. When cells are alive, membranes are functioning and are not permeable to hydrophilic molecules such as propidium iodide. This is why only organic molecules inside dead cells can be stained by propidium iodide. By combining SYTO 24 and propidium iodide, it is possible to distinguish living cells from dead cells. CFDA-AM will yield fluorescent compound upon the reaction catalyzed by esterase, which is the most common reaction found in terrestrial biological organisms [6]. Aerosol corrected on the aerial platforms such as Venus Atmospheric Mobile Platform can be analyzed by LDM [7].

References

[1] Travis, L.D. (1975) *J. Atmospheric Sci., 32,* 1190-1200. [2] Pollack, J.B. et al. (1980) *J. Geophys. Res., 85,* 8141-8150. [3] Shalygin, E.V. et al. (2015) *Geophys. Res. Lett., 42,* 4762-4769. [4] Limaye, S.S. et al. (2018) The Ninth Moscow Solar System Symposium 2018, Moscow, Russia. [5] Yamagishi, A. et al. (2010) *Biol. Sci. Space, 24,* 67-82. [6] Yamagishi, A., et al. (2018) *Trans. JSASS Aerospace Tech. Japan, 16,* 299-305. [7] Lee, G., et al. (2015a) [abstract id.P23A-2109]. American Geophysical Union, Fall Meeting