Possibility for the formation of organic hollow globules around evolved stars

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The existence of various organic materials in extraterrestrial is well known based on astronomical observation. Extraterrestrial organics are expected to play an important role in showing the origin of life on the Earth. Organic matters in the CM2 Murchison were identified as extraterrestrial organics based on their isomeric configuration. The origin of terrestrial organics has been discussed realistically based on analytical studies of terrestrial outgassing. It has been recognized that carbonaceous chondrites supplied significant amounts of organic matter to the young Earth and contributed to the evolution of terrestrial life. In addition, comets have strong supplemental evidence concerning the presence of organics in the primitive solar nebula, because comets, which show some spectral features attributed to carbonaceous materials, are the most primitive solar system bodies in current solar system. Comets are also considered the carrier of the origin of life. Astronomical observations and laboratory experiments have shown that the organic matter in extraterrestrial materials is complex organic.

Recently, the existence of enigmatic organic grains in the Tagish lake meteorite was reported (Nakamura *et al.* 2002). The organic grains, called organic globules, have a construction of shells with a cavity in their center and show via isotopic anomalies of nitrogen and hydrogen, that they are extraterrestrial products. Based on the isotopic composition of nitrogen and hydrogen, which was clearly distinct values in the meteorite matrix, it was proposed that the organic globules were produced with low temperature chemical fractionation in the outer cold region of protoplanetary disk (Nakamura-Messenger *et al.* 2006). The discovery of low temperature organic products gives us a new perspective on the formation of organics. Currently, similar grains have been found in various extraterrestrial materials, such as cometary IDPs and other meteorites. It is the first step to the life birth to form organic matter oneself orbicularity membrane structure. Since organic globules resemble a pouch which is seen in cell, these globules have a potential of the origin of life.

We generated the organic globules from benzene in laboratory. Benzene vapor was introduced into a He plasma field, and then benzene molecules were reacted with plasma components, such as electrons, He ions, and their radicals. After the experiment, we found yellowish depositions on electric plates to generate the plasma. This color implies that depositions are more complex organics. Through the TEM observation using a JEOL 3200FS with a 300kV electron beam, we found that the depositions are spherical globules with the size range of 17-133 nm in diameter. This size is extremely close to that of organic globules in meteorites (140-1700 nm in diameter). In addition, the forty percent of the organic globules have hollow centers. Only 2 % of the laboratory globules with a diameter less than 30 nm have a hollow core, whereas ˜50 % of those with diameters larger than 30 nm are hollow. We concluded that the hollow interior would be formed due to coagulation of vacancies, which are formed by electronic excitation and/or knock-out of carbon atoms by irradiation of the aggregate with protons. This formation process probably occurred in circumstellar outflows around evolved stars, while the globules in meteorites are considered the products in protoplanetary disk.