Possibility of organic synthesis after the flow of water through micro-orifices

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Abstract

Micro-fluid mechanics is an important area of research in modern fluid mechanics because of its many potential industrial and biological applications. However, the field is not fully understood yet [1-7]. When passing ultrapure water (UPW*) and tap water which are dissolving air through micro-orifices, we found that the flow velocity decreased and stopped over time, and membranes were frequently formed in the orifice [8]. Membranes were formed more frequently after the flow of UPW* than after that of tap water [8]. We sought the cause of membrane formation [9]. There are three possible sources of the membrane material: material leached from the acrylic resin of the vessel, organic matter originally present in the water, and air dissolved in water. We experimentally examined each of them, and concluded that the course is air dissolved in water. Raman and infrared (IR) spectroscopy showed that the membrane consisted of organic substances such as carotenoids, amides, esters, and sugars. We irradiated UPW* with ultraviolet light to cut organic chains that may be left in UPW* as contaminants. We found a similar membrane and organic compounds as in nonirradiated UPW*. Furthermore, although the ultrapure water that was kept from contact with air after it was supplied from the ultrapure water maker (UPW_0) and further bubbled with Ar gas (UPW_0 bubbled with Ar) formed no membrane, the UPW_0 bubbled with CO_2 formed

thin membranes containing carboxylic acid salts, carotenoids, or a mixture of both. We found that electric grounding of the orifice reduces the probability of membrane formation. We observed that the jets issuing from an aperture bear negative charges, and assumed that the micro-orifices possess positive charges generated by flows. Consequently, we suggest that organic compounds were synthesized from nonorganic matter in air or CO_2 dissolved in water by the action of hydroxyl radicals generated by flows through micro-orifices. We found similar membranes for sea water as for UPW* and tap water.

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