# Validation on the spiral microstructure formed at interface of the carbonated water in early Earth

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The first stage of molecular bio-history progressed by interactions between the system of intermolecular bonding and the environment. Membrane at interface of water became robust by carbohydrates. Carbohydrates were made from moleules of $CO_2$ and $H_2O$. Atmosphere of primitive Earth was comprised of $CO_2$ and $H_2O$. Solubility of $CO_2$ in liquid water under the high pressure is large. From evaluation of Henry's law, 40 bar of $CO_2$ on initial Earth corresponds with $10^5$ times of 0.0004 bar on today's $CO_2$. However, molecule of $CO_2$ is soluble in water at only low temperature. 98.3% of the $CO_2$ in carbonated water is linear molecule. The linear molecule of $CO_2$ will be incorporated in the through-hole of three-dimensional structure of liquid water as follows.

The molecule of water is described as slightly distorted tetrahedron of $sp^3$-hybridized four orbitals. Two of short O-H bond lengths are associated with covalent bond. Two of long O--H bond lengths are associated with ionic bond. Crystal of ice is usually hexagonal structure (1h: $P6_3/mmc$ 194). There is spiral alignment, although there exist glide planes alternately in $P6_3/mmc$ structure. The hexagonal symmetry is formed by a spiral alignment. That is, short side of tetrahedron and long side are connected alternately by 3 direction of electric coupling force. So, the growth of ice is much faster at the {100} interface than at the {111} interface [1].

The microstructure of $H_2O$ molecules is formed basing on the plane of interface. There is a space of through-hole in the center of each spiral structure. Linier $CO_2$ molecule will be inserted to the through-hole, and the spiral structure is rearranged by its flexibility. It is confirmed that lattice structure of $\alpha$-quartz is an optimum model to represent the microstructure of carbonated water formed at the plane interface [2].

[1] Nada,H., (2009), J. Physical Chemistry B, 113 (2009) 4790-4798.
[2] Karasawa, S., (2016), https://youtu.be/_KRvJ5cClDk

Keywords: Spiral structure, Early Earth, Carbonated water, Crystal growth of ice, $\alpha$-quartz

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