The nucleation of aragonite on the calcite basement as induced by synthetic polypeptide- in situ observation by AFM-

Yuki Araki[1]; Katsuo Tsukamoto[2]; Mihoko Maruyama[2]

[1] Science,Tohoku Univ.; [2] Graduate School of Science, Tohoku University

Crystallization by the interactions among organic materials and minerals is called Biominerallization. One sample is the formation of bivalve shells. Calcite and aragonite are two types of the calcium carbonate($CaCO_3$) crystal. Aragonite is the metastable and is formed at high pressure although some bivalve shells contain prismatic calcites and nacreous aragonites simultaneously. The fomation of aragonite inside the shells and the existence of aragonite under the normal conditions are intrigued and investigated by many groups. The results show that organic matrices in shells control polymorphs of $CaCO_3$ (Hare,1963). And the polypeptide synthesized by Miyashita et al., which contains the specific amino acid sequences, is considered as one of the most effective chemical agents to active the formation of aragonite by the evidence of aragonite nucleation appearing in the supersaturated solution of $CaCO_3$ containing the synthetic polypeptide and Mg^{2+} (Miyashita et al., private communication).

In my thesis, we have investigated the effect of the synthesized polypeptide on the $CaCO_3$ crystal growth by observing the nucleation of (001) aragonite on a(10-14)calcite surface. All experiments were fulfilled in the supersaturated solutions of $CaCO_3$ (SI=2.0) at the room temperature and pH = 8.6. First of all, supersaturated solutions of $CaCO_3$ containing magnesium (Mg^{2+})([Mg^{2+}] = 0.05M) were directly dripped to the surface of calcite seed crystal. After two hours, supersaturated solution of $CaCO_3$ with the synthetic polypeptide ([Mg^{2+}] = 0.05M, the concentration of the polypeptide = 50g/ml) was loaded on the surface of the same seed crystal too. In order to observe the influence of the above chemical components on the pattern of calcite crystal surface, Atomic Force Microscopy (AFM) was employed. Secondly the supersaturated solutions of $CaCO_3$ without Mg^{2+} were explored to asses the function of Mg^{2+}. The results show that rhombic hillocks emerge on the surface of the (10-14) face of calcite seed crystal, which is not due to Mg^{2+}, before the solutions of synthetic polypeptide were added. In contrast to it, the rectangular hillocks appeared on the surface with the assistance of the synthetic polypeptide, and is symmetric when the crystals are orthorhombic. The further test, which is adding the mixture of Mg^{2+} and synthetic polypeptide to $CaCO_3$ crystal surface, shows that the induction time of rectangular hillocks appearing is longer than the one in the supersaturated solution with only the synthetic polypeptide. Our results strongly suggest two issues. The one is that the synthetic polypeptide can form aragonite without Mg^{2+} with the calcite basement. The other is that Mg^{2+} correlates with the effect of the synthetic polypeptide.