

July 16-21, 2017 at UC San Diego, CA, USA

## Formation of Outer Shells from Proteinoid Microspheres

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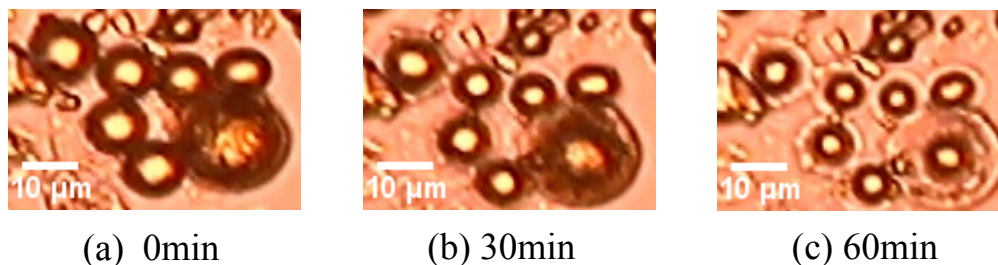
**Introduction:** Modern organisms are composed of cells for physical compartments. For origins of life, physical compartments are believed to be important. Proteinoids are macromolecules formed by heating a mixture of amino acids, and they have similar composition to proteins<sup>[1]</sup>. Proteinoids form into microspherical structure in aqueous solutions by heating and cooling<sup>[1]</sup>. Proteinoid microspheres can form outer shells with increasing pH or thermal gradient<sup>[2,3]</sup>. Haruna considered that the flow of melted proteinoid molecules formed outer shells<sup>[4]</sup>. In this study, we elucidated the mechanism of formation of outer shells from proteinoid microspheres with thermal gradient.

**Materials and Methods:** For this purpose, we examined whether the forced flow of proteinoids formed outer shells from proteinoid microspheres. The heated proteinoid solution was made to flow in the channel that proteinoid microspheres put on. In addition, we made another experiment that the proteinoid solution was kept the temperature constant in thermostatic oven.

**Results:** When forced flow was given to proteinoid microspheres, microspheres began to dissolve and outer shells were formed in about 30 to 60 minutes. Outer shells were not formed when only flow was given, but when only heat (above 40°C) was given, outer shells were formed after 48 hours.

**Conclusion:** We conclude that formation of outer shells from proteinoid microspheres with thermal gradient was caused by dissolution of proteinoid microspheres. Furthermore, we found that the addition of flow promotes the formation of outer shell as compared with heat only.

**References:** [1]Fox, SIDNEY W., and Kaoru Harada., *Science* 128 (1958): 1214. [2]Sakurazawa, Shigeru, et al., *Colloid & Polymer Science* 275.5 (1997): 502-505. [3]Haruna, Taichi, Junya Shiozaki, and Sayaka Tanaka., *Proceedings of the 6th International Conference on Soft Computing and Intelligent Systems*. 2012.



**Figure 1** – Formation of outer shells with forced flow