Tunable Angle Dependent/Independent Structural Color of Hydrogel by Modulating Lamellar Structure

Md. Anamul Haque[a,d], Kei Mito[b], Takayuki Kurokawa[a,c], Tasuku Nakajima[a,c], Takayuki Nonoyama[a,c], Ilyas Muhammad[b], and Jian Ping Gong[a,c]*

[a]Faculty of Advanced Life Science, [b]Graduate School of Life Science, [c]Soft Matter GI-CoRE Hokkaido University, Sapporo 001-0021, Japan

[d]Department of Chemistry, University of Dhaka, Bangladesh

Corresponding Author(s)*[a,c]: gong@sci.hokudai.ac.jp, Telephone/fax: +81-11-706-9011

Abstract

Abstract: In this paper, we report tunable angle dependence of stimuli responsive photonic hydrogels containing multi-lamellar structure of alternative rigid polymeric platelets of high refractive index and ductile polymer matrix of low refractive index. Therefore, the refractive index variation and periodic lamellar spacing satisfies the Bragg's law to diffract visible light and the gel exhibits magnificent structural color. The packing geometry of periodic multi-lamellae of the photonic crystal is fabricated from flat-lamellae to cylindrical lamellae. 1D photonic crystalline lamellar sheet domains forms a rectangular sheet hydrogel in which the lamellar sheets aligned periodically parallel to the top surface. On the other hand, cylindrical rod-like colored gel is achieved by arranging periodic multi-cylinder packing of the lamellar domains. The cylindrical photonic hydrogel exhibits angle independent color whereas the sheet hydrogel reveals strong angle dependency. A rocking curve has been constructed to justify the tunable angle dependency of the multi-lamellar hydrogel. The tunable angle dependency of this photonic material could potentially benefits light modulation, visualization, optical sensing, and display technologies.

Recent Publications (minimum 5)

1. M.A. Haque, G. Kamita, T. Kurokawa, K. Tsujii, J.P. Gong. "Unidirectional Alignment of Lamellar Bilayer in Hydrogel: One-Dimensional Swelling, Anisotropic Modulus, and Stress/Strain Tunable Structural Color." *Advanced Materials* 22, 5110-5114, 2010.
2. M.A. Haque, T. Kurokawa, G. Kamita, Y. Yue, J.P. Gong. "Rapid and Reversible Tuning of Structural Color of a Hydrogel over the Entire Visible Spectrum by Mechanical Stimulation." *Chemistry of Materials* 23, 5200-5207, 2011.
3. M.A. Haque, T. Kurokawa, J.P. Gong. Lamellar–micelle transition in a hydrogel induced by polyethylene glycol grafting. *Soft Matter*, 9, 5223-30, 2013.
4. Y. Yue, T. Kurokawa, M. A. Haque, T. Nonoyama, T. Nakajima, I. Kajiwara, J. P. Gong, "Mechano-actuated Ultrafast Full-Colour Switching in Layered Photonic Hydrogels" Nature Communication, 5: 4659, 2014.
5. K. Mito, M. A. Haque, T. Nakajima, M. Uchiumi, T. Kurokawa, T. Nonoyama, J. P. Gong, "Supramolecular hydrogels with multi-cylindrical lamellar bilayers: Swelling-induced contraction and anisotropic molecular diffusion" Polymers, 2017, In press.



Biography

Md. Anamul Haque graduated in Master of Science from University of Dhaka, Bangladesh in 2008. He achieved the PhD degree from Hokkaido University, Japan in 2011. During doctoral research, he has carried the research on the creation of an anisotropic hydrogel with well define hierarchical structure. Now he is concentrating on high functionalization of the anisotropic hydrogel such as role of sacrificial bond on toughness, multi stimuli color sensor. He has published more than 25 papers in reputed journals and is serving as an Assistant Professor, Department of Chemistry, University of Dhaka. As Assistant Professor of Dhaka University, he is currently working as JSPS fellow at Laboratory of Soft & Wet Matter, Hokkaido University, Japan from October 2015 to present.

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Email: anamul@du.ac.bd