Seminar information

September 27(Tue) 2022, 14:00~15:00

@ 205 Seminar room, Engineering Building No. 4 in Hongo Campus, The University of Tokyo

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Multi-layers with confined fluids for active building surfaces

Buildings consume around one third (about 33 PWh) of our total, global energy supply, and about 50% of global electricity, through lighting, heating and air conditioning. One major problem is that the outer surfaces (the façade, specifically windows) of most buildings are *static*, and unable to change optical properties for shading, solar heat transmission, and light scattering. Being able to control these properties, digitally and inexpensively, for windows would significantly reduce operational energy costs. For example, current approaches for active shading are either low-resolution (e.g., mechanical blinds), expensive (e.g., electrochromic), or inefficient (e.g., dielectrics, liquid crystals).

New, inexpensive materials for smart building façades, with active control of optical properties (shading, scattering and IR transmission) are needed. In the biological world, many organisms, especially marine animals (squid, octopus, krill, crab and fish) have mechanisms to change the optical properties of their skin using the dispersal and movement pigment-containing fluids, for camouflage, UV light protection, and signaling. In this talk, I will present our work to use this kind of bio-inspired design approach, to use confined fluids within multilayered devices to change the effective optical properties of windows, through the composition of the confined fluid itself [1-4].

We have tested the design of various microfluidic systems, expanded over large areas, to use flow of confined fluids to control the total transmitted light intensity (95% modulation between 250-3300 nm), near-infrared-selective absorption (70% modulation between 740-2500 nm), and dispersion (scattering) [1-3]. Also, a reversible injection of pigment 'spots' in an array [2]. This combinatorial optical tunability enables configurable optimization of the amount, wavelength, and position of transmitted solar radiation within buildings over time. Our simulations of building operation show predicted energy reductions of more than 43% over existing technologies.

(1) Kay, R.; Jakubiec, J. A.; Katrycz, C.; Hatton, B. D. Multilayered optofluidics for active building facades. (In review) 2022.
(2) Kay, R.; Katrycz, C.; Nitièma, K.; Jakubiec, J. A.; Hatton, B. D. Decapod-inspired pigment modulation for active building facades. *Nature Communications* **2022,** *13* (1), 1.
(3) Kay, R.; Nitièma, K.; Katrycz, C.; Jakubiec, J. A.; Hoban, N.; Hatton, B. D. Shape-programmable fluid bubbles for responsive building skins. *Journal of Building Engineering* **2021,** *48*, 103942.
(4) Hatton, B. D.; Wheeldon, I.; Hancock, M. J.; Kolle, M.; Aizenberg, J.; Ingber, D. E. An artificial vasculature for adaptive thermal control of windows. *Solar Energy Materials and Solar Cells* **2013,** *117*, 429.

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