Reversible Bandgap Tuning of Crystalline Colloidal Arrays Using Electric Field

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In this study, we report a reversible photonic bandgap tuning of colloidal crystals using electric field. To achieve this, we used highly charged polystyrene particles of ca. 180 nm in diameter which were synthesized through emulsion polymerization by adding ionic comonomer, 3-allyloxy-2-hydroxy-1-propanesulfonic acid (COPS-1) and 2-amino ethyl methacrylate hydrochloride (AEMH) for negative and positive charges, respectively. The charged particles formed crystalline colloidal arrays (CCAs) even in low volume fractions due to the strong electrostatic repulsion. When the AC electric field was applied to CCAs, bandgap of CCAs shifted either blue or red according to field direction due to electrokinetic force. Since electrokinetic force is proportional to AC electric field intensity, magnitude of bandgap shift of CCAs was readily controlled. The CCAs kept their crystallinity for at least 12 000 cycles, and actuation voltage and response time of bandgap tuning were as small as 2 V and 50 ms, respectively. Finally, we could tune the local reflection color with patterned transparent electrodes, demonstrating the possibility of potential applications such as reflective mode displays, optical switches, and tunable mirrors.