Synthesis and characterization of sulfur-rich nanoparticles for daytime passive cooling

Daytime passive cooling, which transfers the heat from hot terrestrial entities to cold outer space through the atmospheric window (8-13 μm) without energy consumption, has attracted more and more attention. On the other hand, sulfur-rich polymers were reported to show excellent optical properties: e.g. high refractive index, high transmittance in MIR range.[i] Recently, highly sulfur content nanoparticles were reported by Shin et al.[ii] Therefore, it would be quite impressive if sulfur-rich nanoparticles can be employed into the fabrication of passive cooler.

The task of this topic is to synthesize sulfur-rich nanoparticles based on the literature and characterize the nanoparticles, in terms of the content of sulfur, particle size, optical properties, e.g. reflectance in visible range and transmittance in MIR range. Subsequently, the fabrication of daytime passive cooler based on the sulfur-rich nanoparticle monolayer or multilayers shall be achieved.

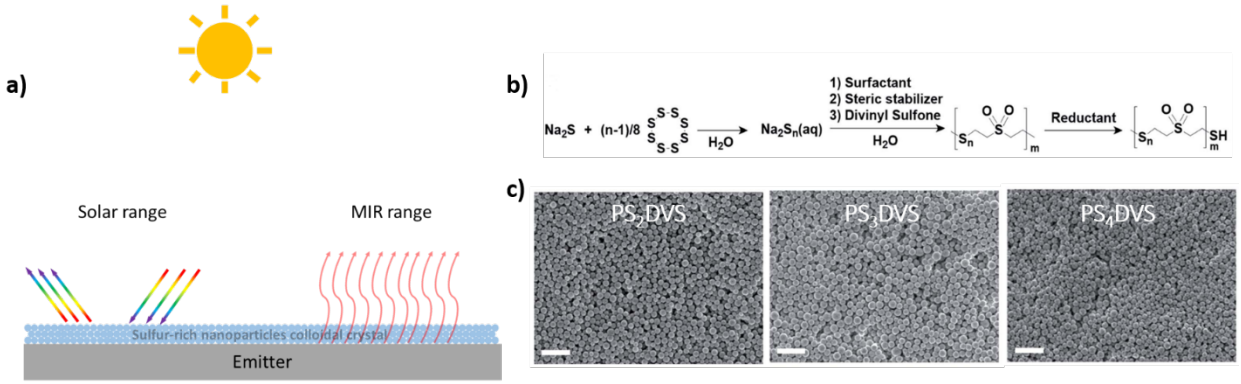

Figure 1. a) Schematic of daytime passive cooler based on the sulfur-rich nanoparticles colloidal crystal. sulfur-rich nanoparticles synthesized by Shin et al.[ii] b) Schematic of the synthesis of sulfur rich poly(sulfur divinyl sulfone) (PS_nDVS) nanoparticles. c) SEM images of PS_nDVS nanoparticles with different content of sulfur: n = 2, 3, 4.

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[i] Griebel, J. J.; Namnabat, S.; Kim, E. T.; Himmelhuber, R.; Moronta, D. H.; Chung, W. J.; Simmonds, A. G.; Kim, K.-J.; van der Laan, J.; Nguyen, N. A.; Dereniak, E. L.; Mackay, M. E.; Char, K.; Glass, R. S.; Norwood, R. A.; Pyun, J., New Infrared Transmitting Material via Inverse Vulcanization of Elemental Sulfur to Prepare High Refractive Index Polymers. *Advanced Materials* **2014,** *26* (19), 3014-3018.

[ii] Shin, H.; Kim, J.; Kim, D.; Nguyen, V. H.; Lee, S.; Han, S.; Lim, J.; Char, K., Aqueous "polysulfide-ene" polymerization for sulfur-rich nanoparticles and their use in heavy metal ion remediation. *Journal of Materials Chemistry A* **2018,** *6* (46), 23542-23549.