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Abstract

Studies on Oriented Polysaccharide Materials Prepared from Evaporative Air-LC Interface

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Introduction

Nature has bestowed organisms with different structural designs to adapt them to survive, even under some of the extreme living environments. The human mind and creative intelligence have led us to synthetically mimic these structural designs and improve the living standards. Liquid crystal (LC) state of polymers is the most preferred for such applications due to their intrinsic combination of mobility and ordering. However, the use of naturally available polymers has rarely been the focus of research and thus we are still unaware of many of the key processes of survival strategies. In this work, I have studied the self-assembly of LC polysaccharide (sacran and xanthan gum) aqueous solutions under a drying environment. The self-assembled deposited structures were found to be highly oriented and upon crosslinking, anisotropically swelling hydrogels were prepared.

Results & Discussion

Sacran solution dried in a limited space, deposited as a thin membrane by bridging the narrow gap between the substrates, by splitting the evaporative air-LC interface. This partitioning phenomenon was analyzed theoretically using the standard equation of a meniscus. The derived equation proved that the splitting of the original meniscus into two menisci actually doubled the available area for evaporation in the limited space. In order to control the deposition of LC domains, xanthan gum was used due to its intrinsic property of thermotropic isotropization with increase in temperature. Stepwise deposition of a transverse lid-like membrane preceding the growth of a vertically deposited membrane bridging the two substrates was recorded. A temperature-concentration-morphology phase diagram could be formulated for the variety of deposited structures and anisotropically swelling hydrogel was prepared upon crosslinking the membranous structure. The size of the LC domains in the drying solution was also found to be major factor governing bridging of the gap between the substrates. Self-assembled platelet-sized domains in the sacran solution could deposit, bridging an eight times wider gap.

Conclusion

The theoretical and experimental results presented here provide an understanding of the behavior of polysaccharides under natural environment. The condensation and deposition approach explored in this work promises a versatile methodology of directional control to design novel biomimetic materials with highly ordered structures.

Keywords: Self-assembly, liquid crystals, polysaccharides, drying interface, orientation