Designer ubiquitin proteins towards controlling calcium carbonate crystallization

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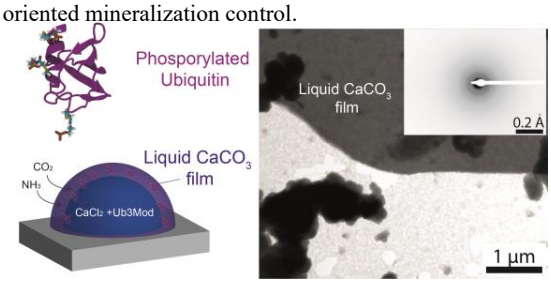
Proteins controlling mineralization in vivo are diverse, suggesting that there are various ways by which mineralization can be directed in bio-inspired approaches [1]. While well-defined three-dimensional (3D) structures occur in biomineralization proteins, the design of synthetic macromolecules with specific, reproducible and predictable 3D arrangements of mineral-interacting functions poses an ultimate challenge. In this context, we used genetically engineered Ubiquitin (Ub) proteins in order to overcome the limitations of generic additive systems. Indeed, Ub with three phosphate functions at defined positions shows unique effects, based on a yet unmatched capability towards the stabilization of a film of a $CaCO_3$ dense liquid mineral phase visible even by naked eye, its transformation into amorphous nanoparticles, and subsequently crystals with complex shapes.[2] In addition, different 3D-arrangment of the phosphate functions within the Ub protein have been proposed by computational methods and studied experimentally regarding the formation of this $CaCO_3$ dense liquid phase.

Herein, we presents designer proteins, as a unique, new generation of crystallization additives where the 3D arrangement of mineral-interacting functions can be designed at will, promising a future use for programmable, target-oriented mineralization control.



[1] S. Weiner, I. Sagi, L. Addadi, Science 2005, 309, 1027.
[2] C. Ruiz-Agudo, J. Lutz, P. Keckeis, M. King, A. Marx, D. Gebauer, J. Am. Chem. Soc. 2019, 141, 31, 12240.