

Publication

Heterogeneous nucleation of three-dimensional protein nanocrystals

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Author(s) Georgieva, Dilyana G.; Kuil, Maxim E.; Oosterkamp, Tjerk H.; Zandbergen, Henny W.; Abrahams, Jan Pieter

Author(s) at UniBasel [Abrahams, Jan Pieter](#) ;

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Nucleation is the rate-limiting step in protein crystallization. Introducing heterogeneous substrates may in some cases lower the energy barrier for nucleation and thereby facilitate crystal growth. To date, the mechanism of heterogeneous protein nucleation remains poorly understood. In this study, the nucleating properties of fragments of human hair in crystallization experiments have been investigated. The four proteins that were tested, lysozyme, glucose isomerase, a polysaccharide-specific Fab fragment and potato serine protease inhibitor, nucleated preferentially on the hair surface. Macrocrystals and showers of tiny crystals of a few hundred nanometres thickness were obtained also under conditions that did not produce crystals in the absence of the nucleating agent. Cryo-electron diffraction showed that the nanocrystals diffracted to at least 4 Å resolution. The mechanism of heterogeneous nucleation was studied using confocal fluorescent microscopy which demonstrated that the protein is concentrated on the nucleating surface. A substantial accumulation of protein was observed on the sharp edges of the hair's cuticles, explaining the strong nucleating activity of the surface.

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