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Drip by drip

An experiment at the University of Konstanz shows non-classical growth of crystals – the result will have implications for basic research as well as for practical applications

How do crystals grow? The answer given in current textbooks is: Layer by layer atoms or molecules settle on an existing crystal surface. The research team Physical Chemistry at the University of Konstanz has now observed a preliminary stage of this crystal growth in glutamic acid that contradicts this classical principal of growth. Not individual atoms settle on an existing crystal surface, but nano-drips that already contain building blocks for growth. This might considerably speed up crystal growth that is of major importance in a number of materials and applications. The liquid state of the building blocks in the preliminary stage might also accelerate the effectiveness of medicines. The results have been published in the current issue of the scientific journal Nature Communications on 21 June 2017.

Professor Cölfen's research team used an atomic force microscope for the measurements in this preliminary stage. The images thus obtained show bright spots that become darker as time progresses, and finally amalgamate entirely with the crystal surface. The atomic force microscope translates brightness into height. The brighter the spot, the higher the component which then spreads until it has reached the height of the crystal surface. It now forms a new crystal layer. "If I create a new layer with atoms or molecules, I need a lot of those. If, however, my solution already contains building blocks, I can add many building blocks to the intended building site in one go", Helmut Cölfen explains the principle: (in text voran stellen!)

The existence of these nano-drips was known already before the Konstanz experiment. They were found for proteins, which are very large macromolecules. Glutamic acid, in contrast, is a single amino acid, a very small molecule. This non-classical growth in such small molecules was observed for the first time. as was the successful measurement. Strictly speaking, the liquid state has not yet been proven, but is concluded from the building blocks' property on the crystal surface. "We think it must be liquids, otherwise the **nano-drips** would not spread in that way", says Helmut Cölfen.

If glutamic acid uses this mechanism of liquid preliminary stages to grow, this might also apply to other molecules. Helmut Cölfen has particularly new formulations for active substances in medicines in mind. As liquids dissolve faster than solid matters, such medicines would become effective much faster. The experiment of the Cölfen research team can also measure the rate at which the layers grow and thus calculate how many building blocks the liquid contains. "This contributes to a fundamental understanding of crystal growth", says Cölfen. Deviations of expected crystal growth can also be explained through this observation.

New physical-chemical theories of crystal growth will now have to be developed to theoretically describe the empirical observation of the liquid preliminary stage. The crucial questions are: Where do these small building blocks come from? Why do they turn liquid? And why can they create a crystal layer? Helmut Cölfen's research team has provided the experimental material for the theory to come.

Original publication:

Yuan Jiang, Matthias Kellermeier, Denis Gebauer, Zihao Lu, Rose Rosenberg, Adrian Moise, Michael Przybylski, Helmut Cölfen: Growth of Organic Crystals via Attachment and Transformation of Nanoscopic Precursors.

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Note to editors:

You can download photos here:

<http://bit.ly/2sh7cxd>

Time sequence of representative images from the atomic force microscope, showing the precipitation and ensuing transformation of the liquid preliminary stages on the surface of a glutamic acid monohydrate single-crystal. The first image (t = 0 minutes) was recorded five minutes after the supersaturated solution was added. More images from left to right after another 3, 9, 15, 26, 31, 34, 37 and 47 minutes. The visibility field is two by two micrometres in size. The coloured circles help to observe what happens to the drips on the crystal surface (dissolution or growth of another layer)

<http://bit.ly/2tiQvQl>

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