Dissolution of ZnO single crystals and the fate of nanoparticles in the environment

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Zinc oxide (ZnO) is a functional oxide of widespread use. It is used as a nanomaterial and, thus, has a high potential to enter the environment. ZnO plays a harmful role because the dissolution leads to the release of cytotoxic Zn^{2+} ions [1]. Therefore, we must understand and quantify the fate of ZnO nanomaterial in the environment.

Here, we study the dissolution mechanisms of ZnO single crystal surfaces using a complementary approach of vertical scanning interferometry (VSI) and atomic force microscopy (AFM). This approach offers a large range of observational length scale. Our approach allows for the quantification of specific rate contributions from etch pits, their density variations and distribution, as well as shape and overall topography (Fig. 1). The surface data are used to calculate material flux maps and are analysed using the rate spectra concept [2]. We focus the change of rate contributors on polar zinc terminated crystal surfaces.

Previous investigations indicate a strong influence of biomolecules on ZnO dissolution kinetics [1]. Furthermore, the interaction of binding peptides is well known to be a surface-specific process. We discuss results about the impact of ZnO binding peptides on reaction rates and their ability to modify the rate spectrum. The presented results improve our understanding about ZnO nanoparticles in the environment.

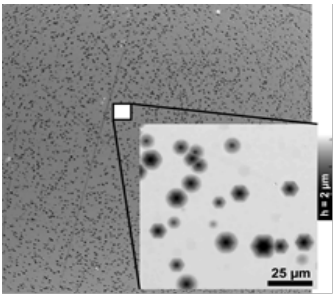

Fig. 1: Dissolution of ZnO results in the formation of hexagonal etch pits. Shape, density and size of pits vary as a function of crystal orientation.

[1] Xia et al (2008), *ACS Nano* **10**, 2121-2134 [2] Fischer et al (2014), *Appl Geoch* **43**, 132-157