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Apatite-(CaSrF) organic composites: from conodont hard tissues to bioinspired materials

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The formation of hierarchical apatite-organic based hard tissues of vertebrates is evolutionary optimized and exhibits high structural complexity on various length scales and amazing mechanical performance. In my presentation I will focus on the detailed characterization of morphology-structure-composition-property relationships of hard tissues of feeding apparatus of one of the earliest vertebrates, namely conodonts. We elaborate and combine exciting evolutionary systems with cutting-edge spectroscopy, microscopy and diffraction techniques to analyze the structural, chemical and morphogenetic basis of the dental-like hard tissue of conodonts. Inspired by this fascinating natural example, we also performed synthesis of strontium substituted apatite-(CaF)-gelatin composites [1]. The effect of the presence of strontium ions in the growth solution on composition, morphogenesis and morphology as well as pyroelectric properties of synthetic aggregates was systemically analyzed. Moreover, the most fascinating result was revealed by pyroelectric microscopy (SPEM). SPEM measurements on mixed substituted apatite-(CaSrF)-gelatin composite aggregates showed an increase in polar properties, suggesting a lowering of the crystal symmetry. This was verified by Rietveld refinement of synchrotron pXRD, which revealed the non-centrosymmetric $P6_3$ apatite crystal structure. These data could shed new light on understanding piezoelectric and pyroelectric properties of apatite based biological hard tissues, and role of strontium ions in biomineralization process.

[1] Knaus, Sommer, Duchstein, Gumeniuk, Akselrud, Sturm, Auffermann, Hennig, Zahn, Hulliger & Sturm (2020), *Chemistry of Materials* 32 (19), 8619-8632.