R. Kniep

The author presented on this page has recently published his ***10th article*** *since 2000 in Angewandte Chemie:* “Planar Fe_6 Cluster Units in the Crystal Structure of $RE_{15}Fe_8C_{25}$ (RE = Y, Dy, Ho, Er)”: B. Davaasuren, H. Borrmann, E. Dashjav, G. Kreiner, M. Widom, W. Schnelle, F. R. Wagner, R. Kniep, *Angew. Chem.* **2010**, *49*, 5688–5692; *Angew. Chem. Int. Ed.* **2010**, *122*, 5824–5828.

Rüdiger Kniep

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Education:	1966–1971 Studies in chemistry and mineralogy at the Braunschweig University of Technology (Germany) 1971–1972 Scientific co-worker at the Philips Research Laboratories in Aachen (Germany) 1972–1974 PhD with Prof. A. Rabenau at the Max-Planck-Institute for Solid State Research, Stuttgart (Germany) 1974–1979 Habilitation at the Institute for Inorganic and Structural Chemistry (Mentor: Prof. D. Mootz), University of Düsseldorf (Germany)
Current research interests:	To develop and establish (novel) classes of compounds with interesting chemical and/or physical properties: Nitridometalates, diazenides, mixed-valency subnitrides, carbometalates, highly reduced cyano compounds, borophosphates, rare-earth chalcogenoborates, and pnictide chalcogenides. Structure/property relationships as well as aspects of applications. Biomimetic growth of functional materials of the human body (bone, teeth, otoconia).

My favorite subject at school was … fine arts.

When I was eighteen I wanted to be … an architect.

The most significant scientific advance of the last 100 years has been … the development of semiconducting materials.

The biggest challenge facing scientists is … complexity.

The greatest scientific advance in the next decade will be … to understand processes of self-organization.

Looking back over my career I would change … nothing.

The three qualities that make a good scientist are … capacity for enthusiasm, fairness, and drive.

If I could have dinner with three famous scientists from history, they would be … Alexander von Humboldt, Charles Darwin, and Alfred Wegener.

I chose chemistry as a career because … I went to great basic chemistry lectures during my first semester as a non-chemistry-student at the University of Technology in Braunschweig.

The most important future applications of my research are … possibly to be found in the field of medicine.

In a nutshell, my research involves … the increase of knowledge in frontier areas of chemistry.

My favorite composers are … Heinrich Schütz and Johann Sebastian Bach.

My worst habit is … impatience.

The biggest problem that chemists face is … to express themselves in a manner intelligible to all.

Young people should study chemistry because … chemistry is a never-ending story.

Is chemistry research different now than it was at the beginning of your career? If yes, how?

The answer to this question is both "yes" and "no". The problems that you work on today, can be quite similar to those worked on 40 years ago. A lot of progress of course has happened concerning techniques. The concept of "materials" has been introduced and contains the aspect of application. Also nanoscale systems are essentially no longer new. Obvioulsy, the trends that do not stem from basic research are the significant ones. I do not mean to criticize this approach; however it is easier to work in a field that is considered to be "mainstream", especially when you are looking for funding. One thing, though, has changed over time: today the formerly common statement "no theoretician has ever helped me along" is certainly no longer valid.

Has your approach to chemistry research changed since the start of your career?

Here I would like to answer "no". However, what has changed—and I am sure all my colleagues will agree—is the scope of my knowledge: it is much wider now. Having a better overview means that connections of course are much more easily recognized. In this sense I can say that I am increasingly in accord with this building called Chemistry.

Has your approach to publishing your results changed since the start of your career?

Definitely. As a young chemist the aim was to publish results as fast as possible (with the necessary accuracy), whereas today I tend to put observations into as broad a context as possible. I am quite reluctant to publish until I have achieved this perspective; therefore manuscripts nowadays stay in my drawer a bit longer.

What do you think the future holds for your field of research?

One of the big challenges in inorganic solid state chemistry is to understand the nature of metal–metal interactions, especially for transition metals. Nowadays, who can answer the question: Which compounds exist in the binary system Ti–Pt? without literature research? Answer: Ti_3Pt, TiPt, Ti_3Pt_5, $TiPt_3$, and $TiPt_8$. But why? Or: Why as well as others does the compound $Mn_{23}Nd_6$ exist in the binary system Mn–Nd? Apart from Zintl phases, these problems are valid for all intermetalic compounds, and also for Laves and Hume–Rothery phases. Similar major challenges are facing researchers in the field of inorganic/organic nanocomposites. This topic even extends into biology and medicine encompassing biomaterials as functional materials in living systems and the elucidation of complex processes related to self-assembly.

Have you changed the main focus of your research throughout your career and if so why?

It was already apparent during my studies that I was not specifically fond of distillations, thus it was clear that I wanted to work on solid state compounds in the broader sense in the future. The first time I came into contact with preparative methods of solid state chemistry was during my PhD when I dealt with tellurium subhalides. Ever since I have focused on the subject of unusual bonding situations in solid state compounds, which hasn't lost its significance to date. I always found compound classes that very little was known about, but which to my perception had great potential, to be very interesting. Thus a range of areas developed that in the course of the experimental work constantly lead to new questions. My interest in questions related to biomineralization may appear a bit exotic in this context; maybe the reason for this interest lies in my academic background. The number and quality of my students have always allowed me to take the following route: observation→question→interest→start. Freedom of research—it cannot get any better than that!

What has been your biggest influence/motivation?

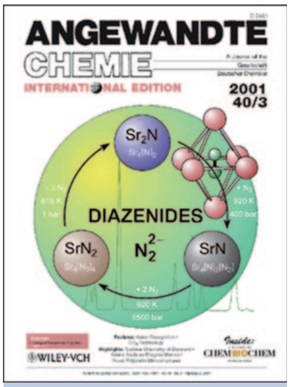
There is no singular outstanding incident, it is simply the essence from miscellaneous personalities from science, research, and industry. Kind of a multivalent motivation.

What advice would you give to up-and-coming scientists?

To develop professional self-confidence and scientific broadness.

What is the secret to publishing so many high-quality papers?

First of all it has to be said that the opinions on whether a paper is classified as "high-quality" often differ; that is the way it is and it will not change either. But it is also true that the acceptance of a manuscript in a high-ranking journal is always a reason to rejoice for the authors. The quality of a paper is significantly influenced by the team of authors and especially by the younger co-workers (students, undergraduate students, graduate students). An enthusiastic team will be able to produce inspiring papers.



The work of R. Kniep has been featured on the cover of Angewandte Chemie "SrN und SrN_2: Diazenides by Synthesis under High N_2-Pressures": G. Auffermann, Y. Prots, R. Kniep, *Angew. Chem.* **2001**, *113*, 565–567; *Angew. Chem. Int. Ed.* **2001**, *40*, 547–549.

My 5 top papers:

1. “Sr_4N_3: A Hitherto Missing Member in the Nitrogen Pressure Reaction Series $Sr_2N \rightarrow Sr_4N_3 \rightarrow SrN \rightarrow SrN_2$”: Yu. Prots, G. Auffermann, M. Tovar, R. Kniep, *Angew. Chem.* **2002**, *114*, 2392–2394; *Angew. Chem. Int. Ed.* **2002**, *41*, 2288–2290.
   A reversible redox intercalation reaction, in the course of which molecular nitrogen is reduced by low-valent strontium to the diazenide. The first step ($Sr_2N \rightleftharpoons Sr_4N_3$) already proceeds under mild conditions and thus easily explains the previous (controversial) reports about the existence of different alkaline earth nitrides, which in fact already had been “contaminated” by nitride diazenides. From my point of view, low-valent states of alkaline earths are also important during ammonia synthesis.
2. “$(Ca_7N_4)[M_x]$ (M = Ag, Ga, In, Tl): Linear Metal Chains as Guests in a Subnitride Host”: P. Höhn, G. Auffermann, R. Ramlau, H. Rosner, W. Schnelle, R. Kniep, *Angew. Chem.* **2006**, *118*, 6833–6837; *Angew. Chem. Int.* Ed. **2006**, *45*, 6681–6685.
   Intermissions included, this work took more than 12 years. The compounds are formed from the elements; single-phase samples and bigger single crystals could hardly be obtained. The host structure (Ca_7N_4) could unambiguously be determined by X-ray analysis; the guest $[M_x]$ within the channels could only be seen as a diffuse tube. Chemical analyses were for the above-mentioned reasons not significant. Then it became clear that the Ca atoms were present in mixed-valent states, thus resulting in an uncharged host structure and therefore uncharged metal chains. With respect to their position in the channels the chains are largely free and (depending on M) in part fragmented. Thus one-dimensional metals and anisotropic semiconductors result, respectively.
3. “Structural Chemistry of Borophosphates, Metalloborophosphates, and Related Compounds”: B. Ewald, Y.-X. Huang, R. Kniep, *Z. Anorg. Allg. Chem.* **2007**, *633*, 1517–1540.
   With our first work regarding borophosphates (*Angew. Chem.* **1994**, *106*, 791–793; *Angew. Chem., Int. Ed. Engl.* **1994**, *33*, 749–751) we opened the door to a class of compounds that until then simply had been overlooked. This is quite remarkable, as at the time porous materials like zeolithes and AlPOs belonged to the up-to-date fields of research. The step towards compounds from the systems M_xO_y-B_2O_3-P_2O_5 (-H_2O) opened up the possibility to integrate one of the components (boron) not only as a tetrahedral building block but as a trigonal-planar group into the structures. Therewith the era of the hunters and gatherers began, which many groups worldwide are active in. Of late there is an increased interest in these compounds with respect to their applications (doping with rare-earth metals and heterogeneous catalysis).
4. “Shape Development and Structure of a Complex (Otoconia-Like?) Calcite–Gelatine Composite”: Y.-X. Huang, J. Buder, R. Cardoso-Gil, Yu. Prots, W. Carrillo-Cabrera, P. Simon, R. Kniep, *Angew. Chem.* **2008**, *47*, 8280–8284; *Angew. Chem. Int. Ed.* **2008**, *120*, 8404–8408.
   This paper was accomplished by “accident”. When investigating the biomimetic formation of carbonate apatite–gelatine composites sporadic calcite composite aggregates appeared, which according to their outer shape coincide with the otoconia (ear dust) that belong to the acceleration sensors in the human inner ear. We investigated this observation in detail and published the first results (even though with unanswered questions). Further (not yet published) investigations show that the outer shape and the inner architecture of the biomimetic otoconia actually do coincide with the biogenic (human) species. Thus we present the first example that confirms it is possible to mimic a biogenic functional material (a biomineral) with respect to outer shape and inner structure in the lab.
5. “Embryonic States of Fluorapatite–Gelatine Nanocomposites and Their Intrinsic Electric-Field-Driven Morphogenesis: The Missing Link on the Way from Atomistic Simulations to Pattern Formation on the Mesoscale”: P. Simon, E. Rosseeva, J. Buder, W. Carrillo-Cabrera, R. Kniep, *Adv. Funct. Mater.* **2009**, *19*, 3596–3603.
   This article is the result of almost 15 years of intensive research in the field of biomineralization (bones, teeth) and is a milestone on the way to deeper understanding of the processes of nonclassical crystallization. Nucleation of the inorganic component starts at/in the biomacromolecules and leads to nanocomposite subunits with a distinct mosaic structure. The subunits then assemble according to principles of self-similarity and produce an intrinsic electric field; through this field, neighboring (polar) macromolecules are integrated into the nanocomposite system in the form of fibrils. Thus the next hierarchical level is reached in which the matrix (the nanocomposite superstructure) is overlaid by a fibril pattern, which reflects the course of the field lines of the growing permanent dipole. A fascinating system, considering that an individuum constructed in such a fashion leads to an X-ray diffraction pattern that corresponds to a single crystal. Possibly we even have found the key to understanding the subsequent fractal development of form.

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