PROGRAMMED ASSEMBLY OF MOLECULAR FRAMEWORKS: A NEW CLASS OF DESIGNER SOLIDS?

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The demand for advanced materials with novel combinations of different functionalities requires the development of new types of solids. Self-assembly of one or different types of functional molecular units can be employed to fabricate crystalline arrangements, yielding complex but at the same time structurally well defined, highly ordered “Designer Solids”, which exhibit functionalities going well beyond that provided by the individual building blocks.

In this presentation, it will become evident that a recently introduced class of supramolecular materials, metal-organic frameworks, or MOFs, carry an enormous potential with regard to the fabrication of solids with unusual physical properties [1]. MOFs are stable materials, with decomposition temperatures well above 200°C (in some cases > 500°C). With selected examples, we will demonstrate the interesting, and often surprising (e.g. negative thermal expansion coefficient), mechanical, electronic, magnetic and optical properties of these molecular, crystalline materials.

We have developed a liquid phase epitaxy (LPE) process, which allows growing MOFs on modified substrates using a layer-by-layer procedure [1]. For the cm-sized, highly oriented MOF thin films with thickness in the micrometer-regime basic physical properties (mechanical [2,7], optical [3], electronic [4], magnetic [5]) of these porous, molecular solids can be determined using standard methods.

The porous nature of these crystalline solids opens up the prospect of adding additional functionality by placing molecules [8] or nanoobjects inside the voids within the MOFs, e.g. metal clusters or dye molecules [9].

Keywords: Designer Solids, Metal-Organic Frameworks, Organic Thin Films

References

[1] H. Gliemann und Ch. Wöll, Materials Today **15**, 110 (2012)
[2] S. Bundschuh, O. Kraft, H. Arslan, H. Gliemann, P. Weidler, C. Wöll, APL **101**, 101910 (2012)
[3] E. Redel, Z. Wang, S. Walheim, J. Liu, H. Gliemann, Ch. Wöll, APL **103**, 091903 (2013)
[4] J.Liu, et al., Angew. Chemie, **54**, 7441 (2015)
[5] M.E. Silvestre, M. Franzreb, P.G. Weidler, O.Shekhah, Ch. Wöll, Adv. Funct. Mat., **23**, 1093 (2013)
[6] Z.Wang, J. Liu, B. Lukose, Z. Gu, P.Weidler, H.Gliemann, T. Heine, C. Wöll, Nano Letters, **14**, 1526 (2014)
[7]. J.P. Best, J. Michler, J. Liu, Zh. Wang, M. Tsotsalas, X. Maeder, S. Röse, V. Oberst, J. Liu, S. Walheim, H. Gliemann, P.G. Weidler, E. Redel, Ch. Wöll, Appl. Phys. Lett., **107**, 101902 (2015)
[8] L. Heinke, Z. Gu, Ch. Wöll, Nature Comm., **5**, 4562 (2014)
[9] W. Guo, J. Liu, P.G. Weidler, J. Liu, T. Neumann, D. Danilov, W. Wenzel, C. Feldmann, Ch. Wöll, Phys.Chem.Chem.Phys., **16**, 17918 (2014)