Metal Fluorides

New Perspectives to a Broad Range of Applications - Coatings, Ceramics, Catalysts

A recently developed fluorolytic sol-gel route to metal fluorides and their specific chemical properties open a broad range of scientific and technical perspectives: they allow highly effective coatings that are thin, deflective and stable; they have proved to be useful in the generation of high-performance ceramics; last but not least, they are powerful catalysts and a suitable alternative to the strongest Lewis acids and their complicated handling.

As a supplier of specialty chemicals for pharmaceutical and chemical companies worldwide, ABCR GmbH & Co. KG, Karlsruhe, Germany has always focused on fluorochemicals and sponsors research in this field. The fluorolytic synthesis developed in our institute is a versatile method and opens up promising new fields of applications.

Metal Fluoride Sols: Coatings for Optics and Photovoltaics

According to the latest techniques, effective de-mirroring requires alternating multi-layer coatings constituted of high and low refractive materials. However, a glass surface could be totally non-reflective if coated with just a single layer holding a refractive index (n550) of just 1.23. This can be produced by introducing controlled porosity to the coated layer - unfortunately followed by a decrease of mechanic stability. If the coating material already shows a very low refractive index less porosity will be needed and higher mechanic stability will be ensured.

The pictures (Figs. 1a and 1b) display a plane glass surface coated with a hard, transparent MgF₂-layer. In the pictures, the small zone on the right side of the surface shows the original, non-coated glass area. Based on these promising results - by further modification of MgF₂-sols prepared - a further decreasing of the refractive index up to 1.23 should be possible.

Inorganic-Organic Hybrid Materials
Organically functionalized nano-metal fluorides can show excellent dispersion behavior in organic systems. Polymerized methacrylates containing up to 40% modified MgF$_2$ are transparent, exhibit a glass transition temperature increased by ca. 25°C and moreover have a mechanic hardness 2.5 times higher than the unmodified polymer.

**Ceramics**

Nano-materials show significantly higher reactivity drastically altering their sintering behavior.

The potential of nano-metal fluorides as sintering additives has been investigated in cooperation with the Fraunhofer Institute for Ceramic Technologies and Systems (Fraunhofer-Institut für Keramische Technologien und Systeme, IKTS): The addition of only 0.1% MgF$_2$ resulted in a decrease of the final sintering temperature by approximately 100°C. Besides improving its mechanical properties the modified coating showed an almost perfect transparence in contrast to opaque "normal" corundum ceramics (pict-high-transparency-ceramic).

This innovative approach opens new dimensions for the production and application of high performance ceramics, such as lightening technologies, hard tools or ceramics for artificial limbs, which all are topics of ongoing research.

**Catalysis**

Fluorine compounds belong a priori to the strongest Lewis acids. But Nano-AlF$_3$ - obtained from the synthetic route mentioned above - exhibits Lewis acidic properties which are comparable to the strongest Lewis acid known, SbF$_5$. With Nano-AlF$_3$ an extremely strong Lewis acid is now available that can be handled under normal atmospheric conditions without hydrolyzing. Furthermore, it is opening new options for the application of solid Lewis acids for many reactions in organic chemistry.

Nano-MgF$_2$ exhibits both Brønsted and Lewis acid functionalities. This new class of bi-acidic solid catalysts can be very precisely tuned regarding their surface Lewis and Brønsted acidic properties and already exhibit better activity and selectivity than even the best currently existing homogeneous catalysts.

**Autor(en)**
Prof. Dr. Erhard Kemnitz, Institute of Chemistry, Humboldt University, Berlin-Adlershof, Germany (www.kemnitzlab.de)

Kontaktieren

ABCR
Im Schlehert 10
76187 Karlsruhe