



GEMSTONES MADE FROM TRANSPARENT POLYCRYSTALS

Dr. Jens Klimke

Gems and jewelry have fascinated people since ancient times. High-quality gemstones are rare and precious due to their scarcity in nature. Simple imitations made of colored glass do not have the effect of gemstones, such as ruby, spinel, and diamond, because of the low refractive index and low hardness of glass, making it less resistant.

The first successfully produced synthetic single-crystal gems were rubies manufactured by Verneuil in 1902. The Verneuil process is still used today, but there are also a number of more advanced methods of growing single crystals for jewelry applications, mostly based on the Czochralski process. These synthesis methods are relatively time-consuming and energy-intensive. In addition, the crystals must be faceted in a costly manner by hard machining and the maximum size is limited by the dimensions of the single crystals.

Fraunhofer IKTS has been developing transparent ceramics for 15 years now. Transparent ceramics consist of a plurality of individual crystals that are essentially fully densified in a sintering process. In conventional ceramics, this succeeds only partially. Because the remaining pores scatter light, ceramics are opaque. Transparent polycrystalline colored "rubies" and "sapphires" were presented and patented by Fraunhofer IKTS several years ago, but the birefringence of the individual crystallites limited the maximum transmission of the ceramics. Therefore, focus of recent development work was on ceramic synthesis of the cubic crystal systems of spinel and fully stabilized ZrO_2 to achieve complete transmission with the corresponding effects.

The ceramic production method offers several advantages. New color options and effects arise from the microstructured polycrystals, near-net-shape production is possible due to the relative ease of processing the green ceramic, and completely new design options that were not possible with single crystals are feasible.

The gemstones produced by Fraunhofer IKTS process are currently being analyzed and cataloged by the German Foundation for Gemstone Research in Idar-Oberstein in terms of their gemological properties.

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- 1 Polycrystal of cubic ZrO_2 .
- 2 Polycrystals of spinel and ZrO_2 .