

50 Years of Engineering Ceramics – From Ideas to Reality

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Over the past 50 years, engineering ceramics have transitioned from laboratory-scale innovations to critical components in high-performance applications across multiple industries. The lecture offers a materials-science perspective on the technological, scientific, and political developments that have shaped this field from the 1970s to the present.

The mid-1970s in Europe were marked by significant economic and political shifts: the oil crisis of 1973/74, growing awareness of resource limitations, and a renewed focus on energy efficiency and technological sovereignty. These pressures created fertile ground for materials innovation—particularly in high-temperature and wear-resistant applications—leading to increased interest in advanced ceramics. Government-funded research programs, such as the DFG priority program “Hochleistungskeramiken”, laid the foundation for systematic ceramic materials development, linking academic research, national laboratories, and emerging industrial players.

Initial breakthroughs focused on oxide and non-oxide ceramics—alumina, zirconia, silicon nitride, and silicon carbide—with tailored microstructures, improved fracture toughness, and innovative forming and sintering techniques. Advances in powder processing, hot pressing, and pressure-assisted sintering enabled a level of microstructural control that made these materials viable for load-bearing and thermally demanding environments.

The talk will trace key developments in composite systems (e.g., ZTA and SiAlONs), reliability assessment (Weibull statistics, lifetime prediction), and their translation into real-world applications—in energy systems, biomedical implants, electronics, and aerospace.

Looking forward, engineering ceramics are poised to play a decisive role in addressing current challenges: hydrogen technologies, electrification, high-efficiency thermal systems, and sustainable manufacturing. Coupled with digital design tools, additive manufacturing, and life-cycle considerations, ceramics are entering a new era—one where their unique properties can be leveraged not just for performance, but also for resilience, sustainability, and circularity.