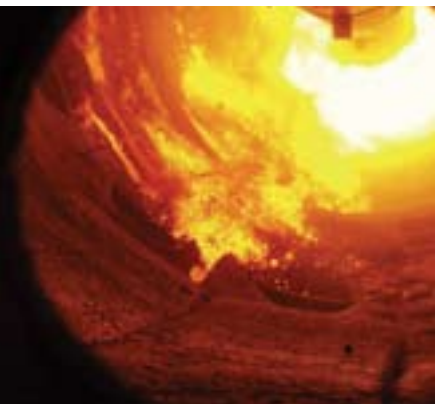
Sustainable cement-based construction materials made by use of nanotechnology

The growing global consumption of cement in the construction industry along with society's increasing demand for a significant reduction in the CO_2 emission represents a major challenge for the cement industry. The vision of FUTURECEM is to use nanotechnology to develop "the sustainable cement of the future".

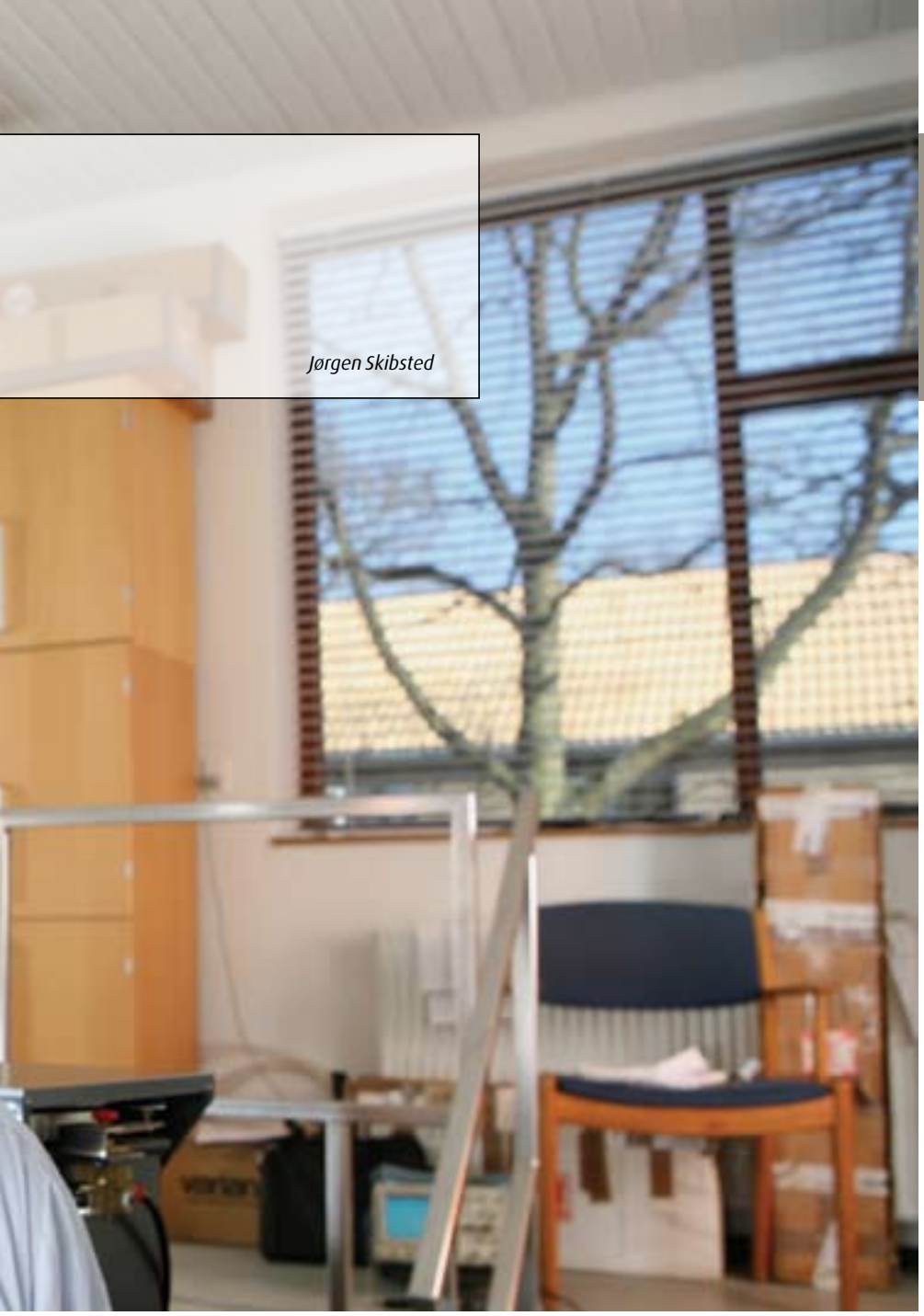
By Jørgen Skibsted



View into the hot end of a rotary cement kiln during production. Raw materials are heated to 1400-1500°C.

The global cement production exceeded two billion tons in 2006, and the demand continues to increase as a consequence of the need for infrastructure, industry and housing in high growth economies such as China and India. Thus, a two-fold increase in the global cement consumption is predicted for 2020 and a three-fold increase for 2050. With present day technology the expected growth will burden the global climate considerably. Today, the production of one ton of cement leads to the emission of 0.8 ton of CO_2, and cement production is responsible for 5 per cent of the global CO_2 emission from human activities.

The FUTURECEM project focuses on the application of nanoscience in the development of new functionalised nanoparticles based on readily available Danish raw materials of low cost, such as clay minerals, that can be used in cement-based materials. The nanoparticles will be combined with



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Application of nanoparticles in modified cement may lead to new building materials with low embodied energy consumption and CO_2 emission. At iNANO solid-state NMR spectroscopy is used as one of the tools to study the interactions between such nanoparticles and cement minerals.

The FUTURECEM collaboration

FUTURECEM is a joint collaboration between Aalborg Portland A/S, the only cement producer in Denmark, iNANO at the University of Aarhus and Aalborg University, and the Geological Survey of Denmark and Greenland (GEUS). The goal is to develop sustainable cement by application of nanoparticles. In 2006 the Danish National Advanced Technology Foundation donated DKK 10 million in support of the three-year project, and the partners contributed with DKK 10 million.

modified Portland cement that is chemically optimised towards high reactivity and compatibility with specific nano-sized additives. The goal is to develop new building materials with low embodied energy consumption and CO_2 emission, a reduced raw material consumption as well as good workability, high strength and durability. The target is to reduce the CO_2 emission by 30 per cent for cement-based materials.

A breakthrough in the application of nanoscience in the cement industry may form the basis for an increased cement production whilst optimising the environmental performance of cement. If successful, the project is expected to have a significant commercial potential in the global cement industry. Furthermore, it will enable Aalborg Portland to introduce nanoparticles to the market as a new commercial product for the construction industry.

Chalk is a natural raw material abundant in Denmark that accounts for the main fraction of raw materials used in the manufacturing of cement.