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Possible Applications of Nanotechnology in Refractory Concrete

Nanotechnology is mainly defined by size and comprises the visualization, characterizations, production and manipulation of structures which are smaller than 100 nm. The structures the dimensions of which range from 100 nm down to approx. 0.1 nm exhibit special mechanical, optical, electrical, and magnetic properties which can differ substantially from the properties of the same materials at larger dimensions. Therefore, nanotechnology is a very active research field and has applications in a number of areas.

The application of nanotechnology is aimed at obtaining the following properties of refractory materials: high resistance to thermal shock, abrasion and chemical corrosion. The researchers try to modify the matrix (binding phase) of advanced refractory materials with nanosized additives.

It was proposed to use of nano spinel (MgAl2O3) precursors in alumina concrete. Nano material was synthesized via sol-gel route under laboratory conditions. The author reported that sol-gel derived spinel bonded concrete matrix showed commendable performance, especially, thermal shock and slag resistance behaviour in the corrosive environment.

The effects of using carbon black (pure elemental carbon in the form of nanoscale particles with a semiamorphous molecular structure) on the physical and thermomechanical properties of Al2O3-SiC-SiO2-graphite refractory composites were investigated. The investigation results showed that nanosize additive effectively improved the oxidation resistance of the material as well as its cold compressive strength.

Different investigations revealed that colloidal (nanoscale) silica and hydratable alumina (amorphous mesophase transition alumina) as a combined binding system also contributed to better advantages to the processing and properties of refractory concrete. The conducted investigation showed that adding nano-sized alumina and silica into corundum-based refractory concrete not only increased compressive strength but also lowered calcining temperature.

Today, technologies for producing nano MgO, Al2O3, ZrO2, Cr2O3 as well as other types exist and the perspectives of using them in refractories also seem to be very high.

When using the materials of nano-particle composition (sodium silicate solution, amorphous SiO2) as binding materials for refractory concretes and in parallel with respectively selected deflocculants (superplasticizers), it is possible to increase the compressive strength and thermal durability of concrete up to 2–3 times.