Materiali avanzati
Advanced Materials

DII research group
Advanced Ceramic
and Glasses

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Investigation conducted in collaboration with Prof. Dusan Galusek and his group at Vitrum Laugaricio, Institute of Inorganic Chemistry, Slovak Academy of Sciences (Trencin, Slovakia). The collaborative research is aimed at developing new strategies for the preparation of inorganic phosphors, for LED devices. A joint EU-project proposal has been recently accepted [H2020-WIDESPREAD-2014 FunGLASS]

Main research topics:

- Nanostructured ceramic composites from preceramic polymers and fillers
- Advanced porous ceramic components
- 3D printing of ceramics
- Bioceramics from novel formulations and novel processing
- Monolithic and cellular glasses and glass-ceramics
- Novel construction materials from inorganic waste and/or recycled glasses
- Porous geopolymers

Gehlenite-based red phosphors from a silicone resin and nano-sized fillers

Silicates of the melilites group may constitute efficient inorganic phosphors, by the introduction of rare-earth ions in the relatively large octahedral sites, normally occupied by Ca^{2+} ions, (sandwiched between layers of interconnected coordination tetrahedra, e.g. $Al_2SiO_7^{4-}$ for gehlenite, $Ca_2Al_2SiO_7$, or $MgSi_2O_7^{4-}$ for akermanite, $Ca_2MgSi_2O_7$).
Gehlenite ceramics have been successfully prepared by the heat treatment of a silicone resin embedding $CaCO_3$ and Al_2O_3, in the form of nano-sized particles that act as reactive fillers. This novel approach allows for a very homogenous mixing: a silicone resin, in fact, is easily dissolved in isopropyl alcohol, and nano-sized oxide particles are easily suspended in silicone solutions. In addition, the fillers may react easily with the amorphous silica, provided by the oxidative decomposition of silicone polymers, possessing a particularly defective network and consequently prone to very favorable reaction kinetics [Fig. 1].
Luminescence was due to the use of nano-sized Eu_2O_3 as secondary additive, particularly adopting a charge compensation formulation, corresponding to $Ca_{2-2x}Eu_{2x}Al(Al_{1+2x}Si_{1-2x}O_7)$, with x=0.07. The phase development and the emission characteristics could be adjusted by simply changing the thermal treatment applied to powders of silicone/fillers mixtures. While conventional firing in air at 1300 °C (for 1 h) led to practically phase-pure crystalline Eu-doped gehlenite [Fig. 2], exhibiting a strong red luminescence, flame synthesis (silicone/fillers powders directly sent into high temperature CH_4/O_2 flame) yielded amorphous powders, exhibiting an emission in a much broader range. When excited at 394 nm both gehlenite glass and polycrystalline gehlenite emitted light, which CIE chromaticity coordinates were found to be (x=0.65, y=0.35), indicating that both systems are good candidates for red light emitting phosphors [Fig. 3].