Study on complex chromium zirconium phosphates for application as inorganic colourants

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Framework phosphates of the NZP family have been widely investigated during the last forty years due to the outstanding physical and chemical characteristics of these compounds. High thermal stability, unique thermal expansion behaviour, structural and compositional flexibility, ionic conductivity and high leaching resistance allow the application of NZP-related phosphates as low thermal expansion ceramics, solid electrolytes, sensors, host material for radioactive waste immobilization, catalysts and colourants.

For many years our department has been engaged in the development of new high performance inorganic pigments and recently we have shown that complex zirconium NZP phosphates are a highly attractive material for colouration of glazes. Excellent chromatic characteristics and hiding power, heat and chemical resistance, which fulfil the strict requirements to inorganic pigments, make the investigated NZP-based compounds outstanding ceramic colourants. We continue our research in this direction working on advancement of synthesis technology of the obtained compounds and looking for new potential colourants of this group.

In our present research, double zirconium phosphates in the system $Na_3Cr_2(PO_4)_3$-$NaZr_2(PO_4)_3$ have been studied for their potential application as inorganic pigments for colouration of ceramic glazes. We have chosen this particular series because Cr^{3+} chromophor represents a special case, where the resultant colour highly depends on the crystal field strength and, accordingly, on co-substitutions in the crystal lattice. Thus, by simple control of the chemical composition, it is possible to shift the absorption bands in the visible range of the spectrum of light with the purpose to obtain the desired colouration - from bright green, like in emerald, to intensive pink, like in ruby. In our case, in $Na_{1+x}Cr_xZr_{2-x}(PO_4)_3$ crystal lattice, chromium shares its position with zirconium and the crystal field strength can be controlled by substitution degree x.

The samples have been prepared by solid state reaction which was upgraded with prolonged ball-mill homogenization and employment of a procedure of pressing before thermal processing. Thermal behaviour of the reaction mixtures was investigated using simultaneous TG/DTA analysis with temperature intervals between 20-1200 ^oC. Evolution of the phase composition in the system was analysed using powder XRD analysis. Thermal stability of the obtained pigments was tested using a heating microscope with automatic image analysis in temperature intervals between 20-1500 ^oC. Stability and the colouring properties of the samples were analysed in a conventional ceramic glaze using VIS-spectrophotometry. In addition, the synthesised compounds have been characterised by particle size distribution measurement.

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