Stabilisation of CuO Aqueous Suspensions

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Abstract. Obtaining ceramic bodies with enhanced mechanical properties via colloidal processing requires efficient dispersion of the ceramic powders. In this work, the dispersive effect of three low molecular weight quaternary ammonium hydroxides with different alkyl groups upon stabilisation of CuO aqueous suspensions is studied and compared with that of Tiron®, a compound based on the benzene molecule. The purpose is to illustrate the effect of molecular structure, size and charge location upon dispersing effectiveness. To access these parameters, rheological and electrophoretic measurements using both bare and surface charge modified CuO were made. Tiron® revealed to be the most efficient dispersant for CuO in water, rendering viscosity values below 1 Pa·s and the highest variation in zeta potential amplitude.

Introduction

Obtaining ceramic bodies with enhanced strength and reliability via colloidal processing requires efficient dispersion of the starting ceramic powders: as thoroughly known, particles arrangement and packing in the green body determines the sintering behaviour and final properties of the component [1-3]. Hence, a uniform dense body can only be attained if the starting suspension has high homogeneity and stability [4]. The stability of a suspension depends on the sign and magnitude of the forces acting between the particles suspended in the medium [5]. In aqueous medium, the attractive forces hindering dispersion are van der Waals forces (strong at the atomic scale), attraction between hydrophobic surfaces (strong), and attraction due to electrostatic connection effects between different sign charged particles (strong). Full dispersion can be attained by adding an appropriate type and amount of dispersant to the system, so that repulsive interactions are developed to oppose those attractive forces. Repulsive interactions may outcome from two major mechanisms acting individually or in combination: electrostatic repulsion [2,6] and polymeric stabilisation [2,6].

In this work, surfactants were added to achieve electrostatic stabilisation of cupric oxide particles in water. Adsorption of surfactants onto the powder surface enables the establishment of an electrical double layer around each particle, keeping them apart. The resultant effects on zeta potential and stability of the suspension depend on the size and structure of the dispersing additives [4,7]. In as much, the effects of molecular characteristics of three quaternary ammonium hydroxides –C₄H₉NO (tetramethylammonium hydroxide, TMAH), C₃H₇NO (tetaethylammonium hydroxide, TEAH) and C₁₅H₃₇NO (tetrabutylammonium hydroxide, TBAH) – upon the stability of aqueous CuO suspensions is studied and compared with the effect of Tiron®. Tiron® is the commercial name for 4,5-dihydroxy-1,3-benzenedisulfonic acid disodium salt, an anionic compound based on the benzene molecule with two ionisable OH groups.