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ORIGINAL PAPER

Comparative study of particle size analysis of hydroxyapatite-based nanomaterials

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The purpose of this work was to compare hydroxyapatite (HAP) and composites of HAP, HAP with chitosan (CS), and HAP with poly(vinyl pyrrolidone) (PVP), in terms of their particle size and morphology, using different methods, such as Coulter counter analysis, X-ray diffraction (XRD), and transmission electron microscopy (TEM). Although many researchers have studied HAP and CS/HAP and PVP/HAP composites extensively, there is no evidence of a comparative study of their particle sizes. For this reason, different complementary methods have been used so as to provide a more complete image of final product properties – particle size – from the perspective of possible applications. The syntheses of HAP and HAP with polymer nanoparticles were carried out employing a precipitation method. Variation in particle size with synthesis time and influence of the reactants' concentration on the materials' preparation were systematically explored. Crystallite size calculated from XRD data revealed nanosized particles of HAP, CS/HAP, and PVP/HAP materials in the range of 2.5–9.2 nm. Coulter counter analysis revealed mean particle sizes of one thousand orders of magnitude larger, confirming that this technique measures agglomerates, not individual particles. In addition, the particles' morphology and an assessment of their binding mode were completed by TEM measurements.

Keywords: nano-hydroxyapatite, chitosan/hydroxyapatite, poly(vinyl pyrrolidone)/hydroxyapatite, crystallite size, X-ray diffraction, Coulter counter analysis

Introduction

Particle size analysis and measurement represents an important parameter for many industries. Different methods and equipment are used for all types of particle size analysis and characterisation. Particle size influences the properties of particulate materials, being a valuable indicator of quality and performance (Harker et al., 1991; Washington, 1992; Merkus, 2009). The stability, chemical reactivity, opacity, flowability, efficacy of delivery, texture and feel, viscosity, packing density, porosity, and material strength of many materials are affected by the size and characteristics of their constituent particles. Measuring particle size and understanding how it affects products and processes can be critical to the success of manufacturing enterprises.

There is no universal method for particle size measurement. Instead, there are different measuring techniques which can be utilised for estimating particle/crystallite size (Halstensen et al., 2006; Hu et al., 2008; Frake et al., 1997). Each method has its own niche wherein it yields the most reliable data. Comparison of particle size data measured by different methods is not simple, due to potential differences in sample preparation, instruments specifications, and

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