Chemical Engineering Journal 214 (2013) 272–277

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Silanized TiO_2 nanoparticles and their application in toner as charge control agents: Preparation and characterization

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HIGHLIGHTS

- We obtain the organic coating layer through micromolecular silane coupling agent.
- Toner charge depends on the numbers of OH groups on the surface of TiO_2.
- The modified TiO_2 is a promising charge control agent.

ARTICLE INFO

Article history:
Received 7 June 2012
Received in revised form 25 September 2012
Accepted 28 September 2012
Available online 10 November 2012

Keywords:
Fourier transform infrared
Organic coating layer
Water contact angle
Specific surface area
Surface morphology
Charge-to-mass ratio

ABSTRACT

Surface modification of TiO_2 nanoparticles with 3-methacrylic acyloxy propyl trimethoxysilane (KH570) was carried out in the liquid phase. As additives, the modified TiO_2 nanoparticles were employed as charge control agents (CCAs) in the toner. The hydroxyl groups on the surface of TiO_2 nanoparticles can interact with methoxy groups of KH570 and an organic coating layer formed. The Ti—O—Si bond was testified by Fourier transform infrared spectra (FTIR). Through transmission electron micrograph (TEM) observation, it was found that the organic coating layer was about ~3.1 nm and the dispersibility of the modified TiO_2 nanoparticles were obviously improved. Static water contact angle was used to investigate the wettability of the modified TiO_2 surfaces. The results indicated that the hydrophobicity of the modified TiO_2 nanoparticle surfaces could be effectively improved as the amount of the coated KH570 increased. The specific surface area (SSA) of the modified TiO_2 was determined by Brunauer–Emmet–Teller (BET) method. Surface morphology of the modified toner and the toner charge were investigated by scanning electron microscopy (SEM) and electrometer, respectively. The modified toner showed smoother surface and the toner charge was adjusted by the modified TiO_2 nanoparticles. The charge-to-mass ratio (Q/M) values shifted to the negative direction, for example −13.25 μC/g, with an increasing coated KH570, probably due to the OH groups existing on the surface of TiO_2.

1. Introduction

The physical properties of the toner particles play a vital role in determining the quality of digital printing with photocopiers and laser printers [1]. Toner particles are usually 5–15 μm in diameter and they consist of polymer (the major component), colorant (pigments) and other additives that help to control the image quality [1–3]. The desirable properties of toner include a homogeneity of composition, a narrow particle size and uniform shape distribution [4].

Currently, the methods to make toners can be briefly described as conventional mechanical grinding and classification [5], and chemically processed toner (CPT) [1,4,6]. In the conventional mechanical toner manufacture, the milling process results in a broad particle size distribution. The narrow particle size distribution can be obtained by air classification, but the mean size of particles decrease due to the yield loss [7]. In the CPT processes, the purpose is to produce the appropriate particle size distribution. In the processes, both milling and classification can be avoided, thus having some advantages over the conventional mechanical toner manufacturing method, such as greater homogeneity of composition, narrower charge distributions, and easier to control the shape of toner particles [1].

In the printing and copying processes, toner is the key material [8]. In order to meet the requirements of the printing and copying, some additives are included in the toner formulations. Many literatures in terms of the adhesion properties between the toner and additives have already published [8–11].

Charge control agents (CCAs), one of the additives, are included in toner formulations to control the magnitude and sign of the

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http://dx.doi.org/10.1016/j.cej.2012.09.125