

Cosmetic properties of TiO₂/mica-BN composite powder prepared by spray drying

Cherng-Yuh Su^{a,b}, Hong-Zheng Tang^b, Kent Chu^c, Chung-Kwei Lin^{d,*}

^aDepartment of Mechanical Engineering, National Taipei University of Technology, Taipei 106, Taiwan

^bInstitute of Manufacturing Technology, National Taipei University of Technology, Taipei 106, Taiwan

^cNational Nitride Technologies Co. Ltd., Taichung 411, Taiwan

^dSchool of Dental Technology, College of Oral Medicine, Taipei Medical University, Taipei 110, Taiwan

Received 22 October 2013; received in revised form 25 November 2013; accepted 3 December 2013

Available online 14 December 2013

Abstract

In the present study, the spray drying process was used to prepare spherical composite powders from TiO₂/mica and h-BN powders. The starting and the as-prepared powders were examined by X-ray diffraction, scanning electron microscopy, particle size analyzer, spectrophotometer, and oil absorption analysis. Particle size distribution, crystalline phases, whiteness, and oil absorption ability were analyzed in order to determine powder morphology. These powders were then mixed into linseed oil to prepare an emulsion for sunscreen protection application. The resultant emulsions were examined using UV–visible–near infra-red (NIR) spectroscopy, sun protection factor tester, and thermal conductivity tester. The experimental results show that spherical composite powder prepared by spray drying not only possess good oil and NIR absorption ability, but also thermal conductivity. The emulsion prepared by spray dried powder exhibits superior sunscreen protection performance compared to its starting counterparts.

© 2013 Elsevier Ltd and Techna Group S.r.l. All rights reserved.

Keywords: C. Optical properties; C. Thermal conductivity; Boron nitride; SPF; Cosmetics

1. Introduction

Solar radiation capable of reaching the Earth's surface falls within the ultraviolet (200–400 nm), visible (400–760 nm), and infrared (760–4000 nm) spectra [1]. UVC (200–290 nm), UVB (290–320 nm), and UVA (320–400 nm) are the three types of ultraviolet light, which is the more detrimental to the human body compared to visible and infrared light [2]. Much of the UVC light is obstructed by the Earth's atmospheric ozone layer [3]. Most UVB and UVA light, however, can reach the Earth's surface, making both the main forms of UV light that damage human skin. Of the two, UVB has shorter wavelength and higher levels of energy, and exposure can cause redness of the skin's epidermis layer and also seriously damage DNA [4]. Although UVA has less energy and causes a

relatively minor sunburn, UVA's longer wavelength enables it to reach the skin's dermis layer, stimulating melanin and causing the dermis layer's collagen and elastin to degenerate. As a result, elasticity of the skin is reduced and wrinkles are induced. UVA's detrimental effects also include the occurrence of free radicals that further damage skin cells [5].

Though UV light possess higher energy than visible light or near infrared (NIR), its relative amount in total solar energy is ~7%, far less than that of NIR (~30%) [6]. NIR (or IRA, 760–1440 nm) can penetrate skin deeply. Half of the NIR may be absorbed by dermis and while the rest can reach subcutaneous tissue [7]. NIR may induce aging of skin cells [8,9], subcutaneous tissue congestive fever, and even skin cancer [10].

Cosmetic material, usually sold in form of sunscreen, is one of the more common forms of protection used to protect the skin against the solar radiations. The mechanisms of such cosmetic materials can be either chemical or physical. Chemical sunscreen agents typically use organic compounds to

*Corresponding author. Tel.: +886 2 27361661x5115;
fax: +886 2 27362295.

E-mail address: chungkwei@tmu.edu.tw (C.-K. Lin).

absorb UV light and many commercially available sunscreen products with a high sunscreen protection factor (SPF) have a high concentration of such organic compounds. However, prolonged exposure of these compounds to UV radiation can cause adverse effects, such as skin irritation, that result from the phototoxic or photochemical reactions of the organic compounds [11]. In contrast, physical sunscreen agents absorb, reflect, and refract UV light. Physical sunscreen agents are typically inorganic compounds and usually result in less irritation and fewer allergic reactions on human skin. Titanium dioxide, mica, and boron nitride are examples of inorganic physical sunscreen agents that are commonly used in the cosmetic industry [12–17]. Attempts to modify these inorganic materials have been performed in order to improve their efficacy [18]. For examples, a previous study by Jaroenwor-aluck et al. indicated that fabricated silica-coated TiO_2 nanoparticles can be effective as sunscreen material [19]. A later study performed by Ren et al. reported that the reflectance of TiO_2 -coated mica increases as the amount of TiO_2 applied increases [20]. Furthermore, Caton used spray drying process to prepare white pigments composed of titanium dioxide and kaolin [21]. Spherical composite powder coupling organic and inorganic materials possess beneficial characteristics and can be used for cosmetics application [22,23]. In addition, BN-coated CeO_2 particles exhibited higher transparency and more effective UV blocking performance than conventional TiO_2 or ZnO-coated CeO_2 particles [24]. It should be pointed out that the above mentioned cosmetic research concerns only UV protection. No cosmetic research concerning IRA has been reported, though numerous medical research [1,2,8,9] has revealed the influence of IRA on human skins.

In this study, the starting materials utilized are titanium dioxide coated mica (TiO_2/mica) and boron nitride powder. Composite powders will be prepared using disc spray drying

processes. Electron microscopy, particle size analyzer, X-ray diffraction, spectrophotometer, and oil absorption analysis will be performed to characterize the starting and the as-prepared composite powders. Preparation of the emulsion will involve adding the starting material and composite powders to linseed oil. The resulting emulsion will then be analyzed to determine its corresponding optical properties and its thermal conductivity.

2. Experimental

2.1. Preparation of TiO_2/mica and h-BN composite powders

Spray drying process was used to mix homogeneously the starting powders to fabricate composite powders. Two commercially available powders were used as the starting materials, which were TiO_2 -coated mica (TiO_2/mica , UV909, Sunshine Mineral Company Co., Ltd. Taitung, Taiwan) and h-BN (Cna04, National Nitride Technologies Co., Ltd. Taitung, Taiwan) powders. TiO_2/mica and h-BN powder (4:1 or 1:4 with a total weight of 500 g) were added into DI water (1000 ml), magnetically stirred, and ball milled to obtain homogenous TiO_2/mica and h-BN dispersed solution. A spray drying system (CNK SDDNO-3, IDTA Machinery Co., Ltd., Taipei, Taiwan) was used to spray the dispersed solution using the process parameters of: in air=180–200 °C, out air=70–90 °C, chamber temperature=80–100 °C, disc rotation speed=30,000 rpm, and the feed rate was ~ 3 kg/h. The schematic illustration of equipment setup was shown in Fig. 1. The spray dried powder was further annealed at 800 °C for 1 h. For emulsion preparation, TiO_2/mica , h-BN, TiO_2/mica and h-BN composite powders were mixed with linseed oil with a powder to oil ratio of 20 wt%.

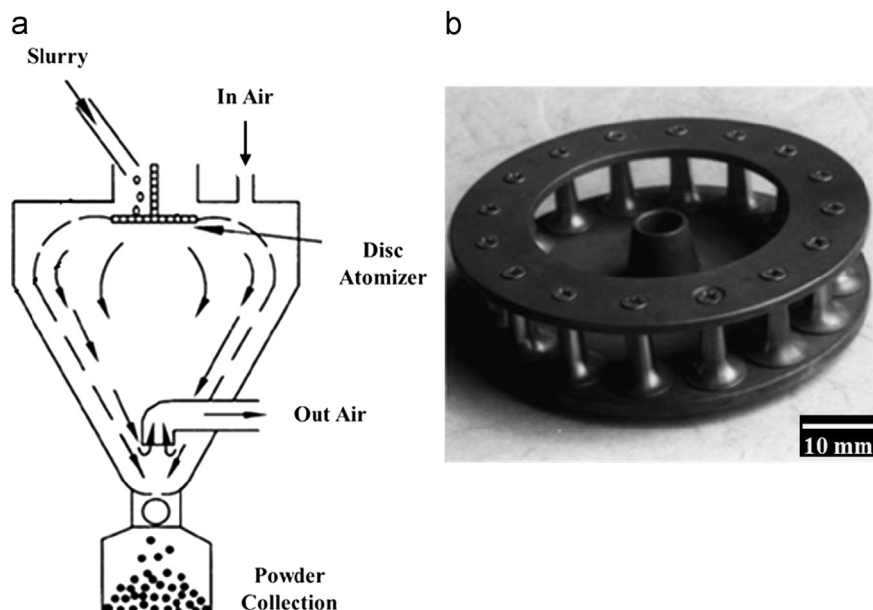


Fig. 1. (a) Schematic illustration of spray drying system and (b) entity figure of disc atomizer.

Download English Version:

<https://daneshyari.com/en/article/1461151>

Download Persian Version:

<https://daneshyari.com/article/1461151>

[Daneshyari.com](https://daneshyari.com)