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Impact of silica-coating on the microwave absorption properties of carbonyl iron powder

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ABSTRACT

Microwave absorption properties, especially the band width and depth of reflection loss are highlighted as key measurement in studies of microwave absorber. In order to improve the band width and depth of reflection loss of carbonyl iron powder (CIP), we prepared SiO_2 layers on the surface of CIP by using tetraethyl orthosilicate (TEOS) as a SiO_2 source and 3-aminopropyl triethoxysilane (APTES) as a surface modifier. SiO_2 layer was formed by the hydrolysis of TEOS. The results show that after treatment the CIP is covered by a 5–10 nm coating layer. Contrast to uncoated samples, coated samples show improved absorption properties. The minimum of reflection loss is −38.8 dB at 11 GHz and the band width of reflection loss exceeding −10 dB is from 8 GHz to 14 GHz.

1. Introduction

The application of wave-absorbing material is the effective way to alleviate the increasingly serious electromagnetic wave pollution [1–4]. Carbonyl iron powder is one of the common wave-absorbing materials. It is hoped that through the modification of carbonyl iron powder to further strengthen its effective absorbing bandwidth and the strength of the wave-absorbing [5–7]. Common modification methods include, transform the microstructure of CIP through ball-milling or altering the preparation conditions and so on [8,9], composite the CIP with other materials by methods as coating, etc [10–15].

In previous studies, the CIP@SiO_2 was proved to be an effective means of modification [16, 17]. As the Reference [16], the author put polyvinylpyrrolidone as surface modifying agent, and TEOS as silicon source for preparing CIP@SiO_2 TEOS, the bandwidth of the reflection loss which is less than −8 dB achieved 10 GHz; In reference [17], the author prepared CIP@SiO_2 by drying and dehydration of silica solution, the bandwidth of the reflection loss which is less than −10 dB achieved 3.8 GHz. But both references are lack of convictive analysis about the absorbing mechanism of CIP@SiO_2.

In this study, a SiO_2 coating layer is prepared on the CIP surface by chemical bath deposition of APTES and TEOS in the ethanol-water solution. The CIP@SiO_2 was prepared via this method and applied for wave-absorbing material that is a first try. In addition,

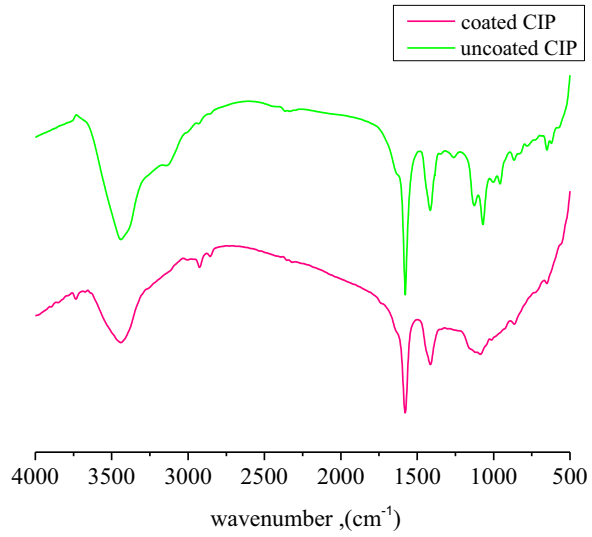

Fig.1. The infrared absorption spectroscopy of the coated sample and uncoated sample.

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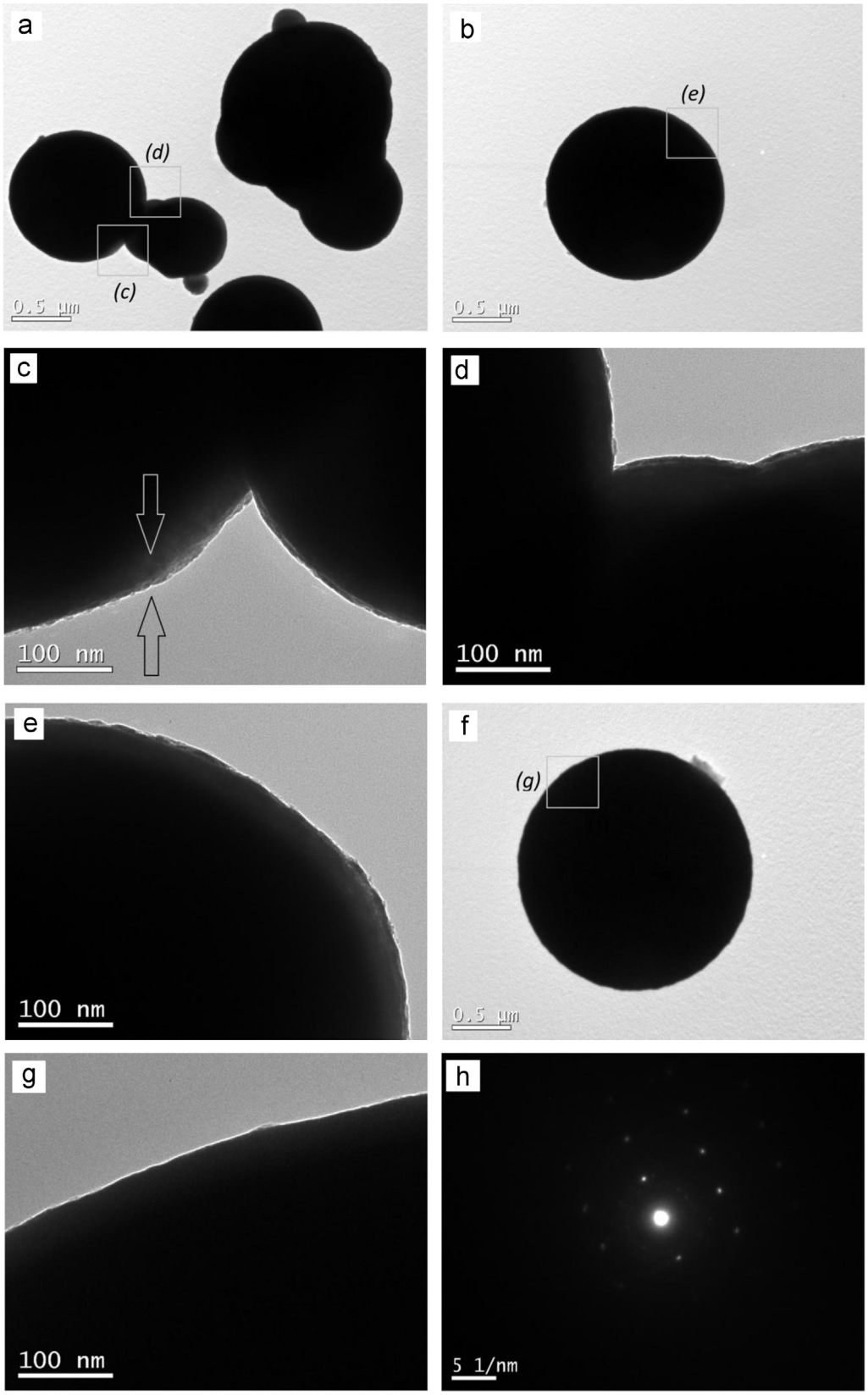

Fig. 2. (a) and (b) are the TEM photos of the coated powder ($x=3$) under low magnification, (c)–(e) are the TEM photos of the coated powder ($x=3$) under high magnification, (f) and (g) are the TEM photos of the uncoated powder (f is under low magnification), (h) is the pattern of electron diffraction of coated powder.