

Study for surface oxidation for nano metal powders under hydrolysis reaction

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1. Introduction

Nanostructures of ceramics have been attracted considerably due to unique physical properties which is quite different from those of the bulk phases [1]. Much effort has been made to the synthesis of nanomaterials with different shapes, such as nanofibers[2], rod-like shape[3] and nanocubes [4]. Due to their applications in nanoscale encapsulation, drug delivery, memory devices catalytic effect such as absorbents of radio isotope, and catalase are also of great interest. The several metals react to hydroxide formula such as $M \cdot (OH)$, $M \cdot (OH)_2$ and $M \cdot O(OH)$ ($M = Al, Ti, Fe, Ni$ and Cu) in aqueous solution.[2-4]. These materials change to transition metal oxides (TMOs) with much potential applications under dehydration treatment. In this study, the oxidation of nano metallic powder such as Al, Fe, and Cu was carried out using hydrolysis reaction, and its tendency and formation were investigated

2. Experiments

High purity nano Al, Fe and Cu powders were synthesized by a pulse wire evaporation (PWE) method. The metal powders were spherical shapes with well-defined boundaries and average sizes of about 80-100 nm.

(i) Al-hydroxide of bohemite ($AlOOH$) and Fe-hydroxide of goetite ($FeOOH$)

The nano Al powders were immersed into distilled water and ultrasonically treated for 10 min. The hydrolysis was carried out for 6 hours at 60 °C to produce the precipitation of metal hydroxide of aluminum. The produced gel was drawn through a 0.2 μm filter and subsequently dried in an oven at 60 °C for 12 h, which yielded the solid precipitates with a white color.

The nano Fe powders were immersed and stirred in distilled water as same as procedure for Al powder. In case of synthesis of goetite, a small amount of acetic acid was added in stirred water. The produced gel was filtered and dried, also. The yielded the solid precipitates show a yellowish brown color.

(ii) Cuprite (Cu_2O)

The nano Cu powders were immersed and stirred in distilled water as same as procedure for Al and Fe powders. However, the hydrolysis was carried out for 6 hours at 40 °C. The produced gel was drawn through a 0.2 μm filter and subsequently dried in an oven at 40 °C for 12 h. In case of hydrolysis of Cu, the final product of as-dried state was cuprite (Cu_2O) with reddish brown color.

3. Results and Discussion

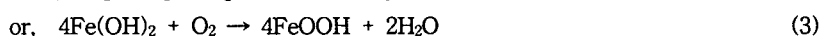
(i) Al-hydroxide of bohemite ($AlOOH$)

When the Al metal particles are hydrolyzed with water, either monohydroxide of bohemite $AlO(OH)$ or trihydroxide of bayerite $Al(OH)_3$ can be produced through the following reactions:[2]



(ii) Fe-hydroxide of goetite ($FeOOH$)

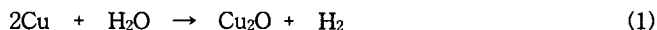
The XRD patterns of as-prepared nano fibrous iron hydroxides and iron oxides show that all peaks can be indexed as $FeOOH$, $Fe(OH)_3$, and $\gamma\text{-}Fe_2O_3$ phases. When the Fe metal particles are hydrolyzed with water, iron hydroxides can be produced through the following reactions: [3]



After hydration treatment of nano Fe powders in this study, it was found that iron hydroxide gels changed into $Fe(OH)_3$, and $FeOOH$ which are phases with cubic ($a = 8.370 \text{ \AA}$) and orthorhombic ($a = 4.6188 \text{ \AA}$, $b = 9.9528 \text{ \AA}$, $c = 3.0236 \text{ \AA}$), respectively.

(iii) Cuprite (Cu_2O)

After hydration treatment of nano Cu powders in this study, it was found that copper changed into cuprite, as shown in Fig 1. When the Cu metal particles are hydrolyzed with water, cuprite can be produced through the following reactions:



The reaction temperature plays an important role in the time of reaction Cu_2O cubes. Our experiment is conducted at 40 °C.

Figure 1 represents deformative shape of AlOOH , FeOOH and Cu_2O synthesized by hydrolysis reaction.

4. Summary

The nature of the surface oxidation on Al, Fe and Cu reacted in distilled water. The oxygen passivated layer is one of main motivations of deformities phase of oxide materials such as bohemite (AlOOH), goetite(FeOOH) and cuprite (Cu_2O). The deformities shapes of oxidized materials were nano-fiber, nano-rod, and nano-cube, respectively. The hydrolysis reaction affect to deformative shape of nano metallic powder under controlled oxygen supplies.

Acknowledgement

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Reference

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- [4] Z. Wang, X. Chen, J. Liu, M, Mo, L. Yang, Y. Qian, *Sol. Stat. Com.*,**130** (2004), 585.

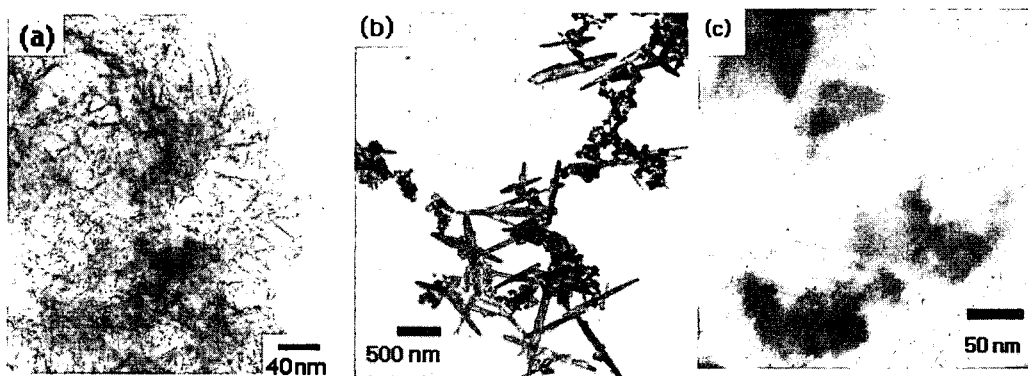


Fig 1 TEM images for (a) AlOOH , (b) FeOOH and (c) Cu_2O fabricated by hydrolysis reaction.