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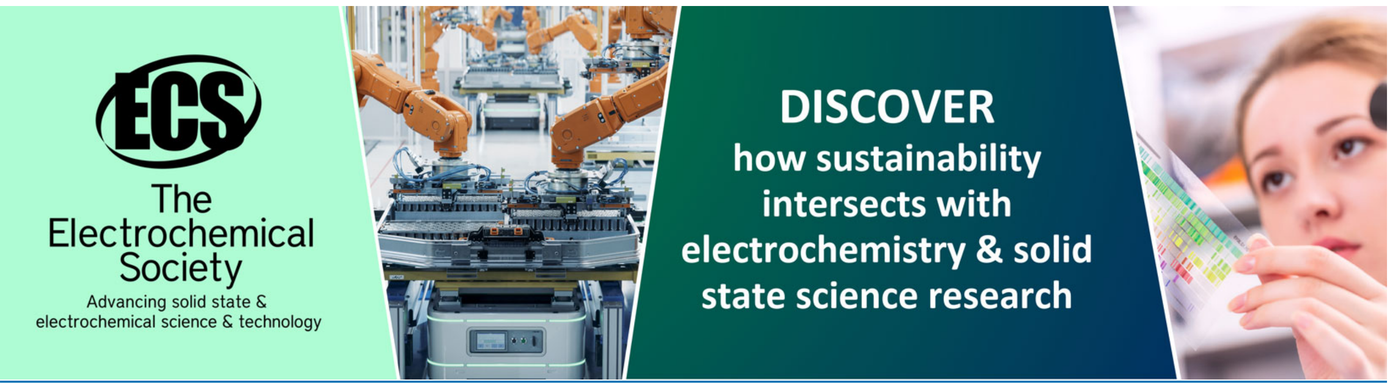


Comparative study on properties of zinc ferrite and its purified products

Jinlin Yang[1,2,a], Shuo Xu[1,b], Pengyan Zhu[1,c] and Shaojian Ma[1,2,d]*

[1]College of Resources, Environment and Materials, Guangxi University, Nanning 530004, China

[2]Guangxi Key Laboratory of Processing for Nonferrous Metallic and Featured Materials, Guangxi University, Nanning 530004, China

[a]email: 1915392020@st.gxu.edu.cn, [b]email: 1815302014@st.gxu.edu.cn

[c]email: 1815392008@st.gxu.edu.cn

*Correspondence author: [d]email: 1615391004@alu.gxu.edu.cn

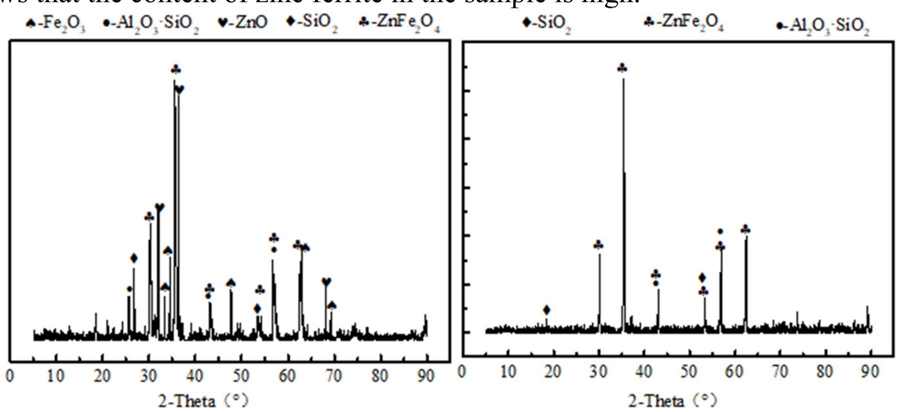
Abstract: In this paper, aimed at the zinc ferrite products from the gossan bearing-zinc ore by direct roasting and their sulfuric acid leaching products, the differences of related products in element composition, mineral composition, specific surface properties and particle morphology were studied. The results show that the XRD diffraction peaks of low content zinc ferrite products are more complex and have more impurity peaks than those of high content zinc ferrite products and less impurity peaks. The XRD patterns of leaching residue have little difference after sulfuric acid leaching purification, but the high content zinc ferrite products have higher crystallinity, the diffraction peak of zinc ferrite from leaching residue is stronger. That is to say, the content of zinc ferrite in the roasted product will not affect the final purification effect by sulfuric acid leaching purification. The phase composition of the purified product is similar, which the main component is zinc ferrite, and contains impurities such as gangue minerals. The adsorption-desorption curves of two purified zinc ferrite products are of type III, but the curves of two products are different. The specific surface area of sample 1 is 9.66 times that of sample 2. The Pore volume and average pore diameter are 8.14 times and 1.97 times, respectively. Therefore, the purified zinc ferrite products with low content of zinc ferrite will have more application potential as adsorbents. There are relatively few soluble impurities in the high content zinc ferrite products, so the micro-morphology of the samples has little change after leaching. However, there are more soluble impurities in the low content of zinc ferrite. After leaching purification by sulfuric acid, the position of the soluble impurities becomes pore, the large particles are decomposed and the particles become finer.

1. Introduction

Zinc ferrite has excellent properties and is widely used in industry. For example, It can be used to prepare coating with high temperature resistance, corrosion resistance and non-toxic for its stable structure, non-decomposition at high temperature, non-toxic to human body, non-soluble in weak acid and weak base[1]. It can be used to prepare magnetic equipment such as electromagnetic switch because of its good soft magnetic effect[2,3]. It can be used to prepare catalyst, which is used to adsorb and degrade water pollutants for its good photo-catalytic performance[4-6]. It can be used to improve the dielectric loss of the composite materials, enhance the anti-electromagnetic radiation effect of the materials, and make the coating materials with wave-absorbing characteristics[7]. In addition, zinc ferrite is an excellent photoelectric conversion material, which is sensitive to visible light and does not corrode, and the photoinduced charge separation speed of nano-particles is faster. Gossan is composed of iron, manganese, calcium, silicon and aluminum oxides, hydrous oxides, secondary sulfate, various alum and clay mixtures mixtures. It is generally distributed in the upper part or near the primary sulfide deposit. After the gossan ore is mined out, it is abandoned, which increases the cost of mining production, causes the waste of metal resources and the hidden danger of environmental pollution caused by long-term stacking. In this paper, aimed at the zinc ferrite products from the gossan bearing-zinc ore by direct roasting and their sulfuric acid leaching products, the differences of related products in element composition, mineral composition, specific surface properties and particle morphology were studied by comparative characterization analysis, so as to accumulate basic data for further application of zinc ferrite.

2. XRD analysis of zinc ferrite prepared by roasting

The XRD patterns of samples with different preparation conditions are quite different. Two typical zinc ferrite products with different conditions are selected for XRD analysis. The content of zinc ferrite is 75.3% in low content products, and 88.6% in high content products. The XRD patterns of zinc ferrite products are shown in Fig. 1. It can be seen from Fig. 1(a) that the diffraction peak of zinc and iron impurity is obvious, and the clear diffraction peak of zinc ferrite can be seen at the same time, which indicates that there are zinc ferrite and zinc and iron impurity. As can be seen from Fig. 1(b) that the XRD patterns of the samples mainly show the diffraction peaks of zinc ferrite and the weaker diffraction peaks of silicon dioxide, and the diffraction peaks of zinc and iron impurities are almost invisible. It shows that the content of zinc ferrite in the sample is high.



(a)Low content zinc ferrite (b)High content zinc ferrite

Fig. 1 XRD patterns of zinc ferrite products

3. Study on the properties of zinc ferrite purified by sulfuric acid leaching

3.1 XRD analysis

The XRD patterns of two types of purified zinc ferrite products are shown in Fig. 2. From Fig. 2, the XRD patterns of leaching residue have little difference after sulfuric acid leaching purification, but the high content zinc ferrite products have higher crystallinity, the diffraction peak of zinc ferrite from leaching residue is stronger. That is to say, the content of zinc ferrite in the roasted product will not affect the final purification effect by sulfuric acid leaching purification. The phase composition of the purified product is similar, which the main component is zinc ferrite, and contains impurities such as gangue minerals.

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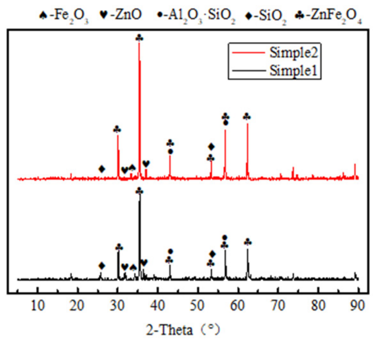
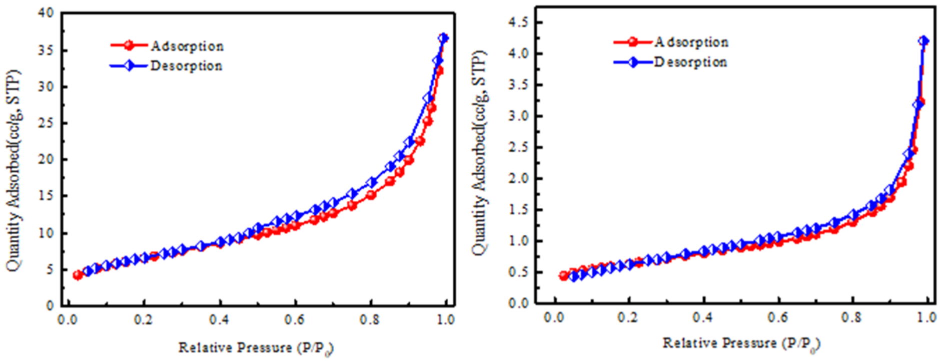


Fig. 2 XRD patterns of purified zinc ferrite products

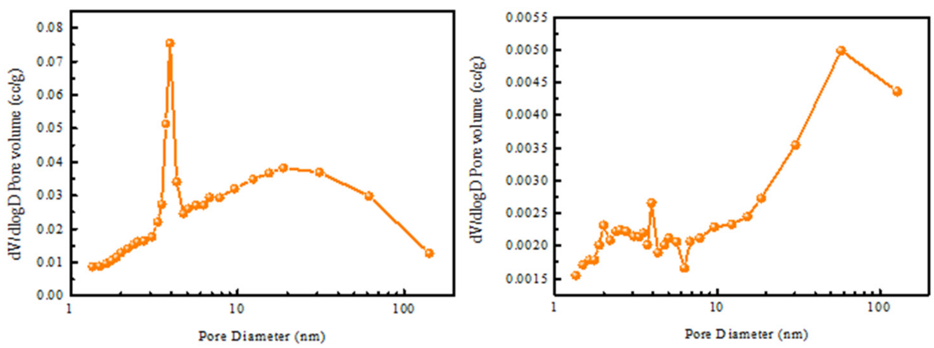
3.2 BET analysis

The isothermal adsorption desorption curves of the purified zinc ferrite products from sample 1 and sample 2 after sulfuric acid leaching purification are shown in Fig. 3. According to BJH model, the pore size distribution of purified zinc ferrites are obtained as shown in Fig. 4. The specific surface area, pore volume and average pore size of the products are shown in Table 1.



(a)Simple 1 (b)Simple 2

Fig. 3 Nitrogen adsorption and desorption curve of purified zinc ferrite products



(a)Simple 1 (b)Simple 2

Fig. 4 Pore size distribution of purified zinc ferrite products

Table 1 Surface parameters of purified zinc ferrite products of the samples.

Sample	Specific surface area/$m^2 \cdot g^{-1}$	Pore volume/$m^3 \cdot g^{-1}$	Mean aperture/nm
1	27.326	0.057	3.936
2	2.830	0.007	2.001

It can be seen from Fig. 3 that the adsorption-desorption curves of two purified zinc ferrite products are of type III, but the curves of two products are different. The maximum value of sample 1 is much larger than that of sample 2, which is 10 times higher than that of sample 2. From Fig. 4, the pore size distributions of the products are different. The average pore size of the purified zinc ferrite product from sample 1 is about 4nm, most of them are mesopores, the average pore diameter of sample 2 is about 2nm, and most of them are micropores. As can be seen from Table 1, the specific surface area of two products is quite different. The specific surface area of sample 1 is 9.66 times that of sample 2. The Pore volume and average pore diameter are 8.14 times and 1.97 times, respectively. Therefore, the purified zinc ferrite products with low content of zinc ferrite will have more application potential as adsorbents.

3.3 SEM/EDS analysis

The SEM images of the purified zinc ferrite products of sample 1 and sample 2 are shown in Fig. 5 and Fig. 6. As can be seen from Fig. 5(a), the particle size of zinc ferrite prepared changed greatly, and many smaller particles appeared, but the changes was relatively small for larger particles. In Fig. 5(b), more impurities are present on the surface of the larger particles. According to Fig. 5(c) and Fig. 5(d), the shape of the smaller particles has changed considerably, from lamellar to elongated, and the layered structure has become more numerous. It can be seen from Fig. 6, the SEM images of the samples after sulfuric acid leaching purification are almost identical to those of the products prepared by direct roasting, and the particle size of the impurities adhering to the surface of the larger particles becomes smaller. Therefore, the pore structure has not changed much. Compared with Fig. 5 and Fig. 6, it is possible that the impurities are removed during the acid leaching process and their areas where the impurities were present become porous structures.

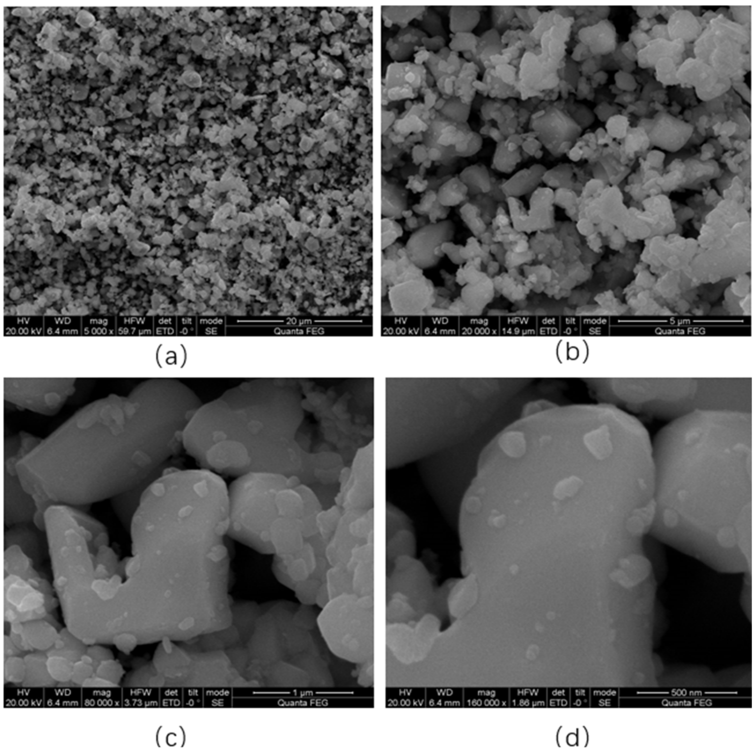


Fig. 5 SEM images of purified zinc ferrite product of sample 1
(a)5000× (b)20000× (c)80000× (d)160000×

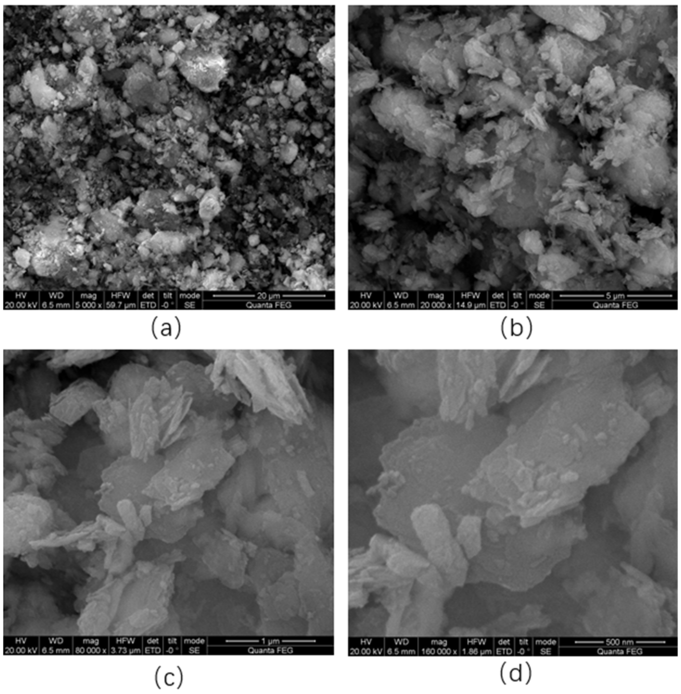


Fig. 6 SEM images of purified zinc ferrite product of sample 2
(a)5000× (b)20000× (c)80000× (d)160000×

EDS diagrams of purified zinc ferrite products are shown in Fig. 7 and Fig. 8. As can be seen from Fig. 7 and Fig. 8, the elemental compositions of the purified zinc ferrite products from the samples are similar, and the diffraction peaks of Ca, Si and Al in the products are weaker than those in the products prepared by direct roasting, which may be due to leaching process, these elements are partially soluble in an acid solution.

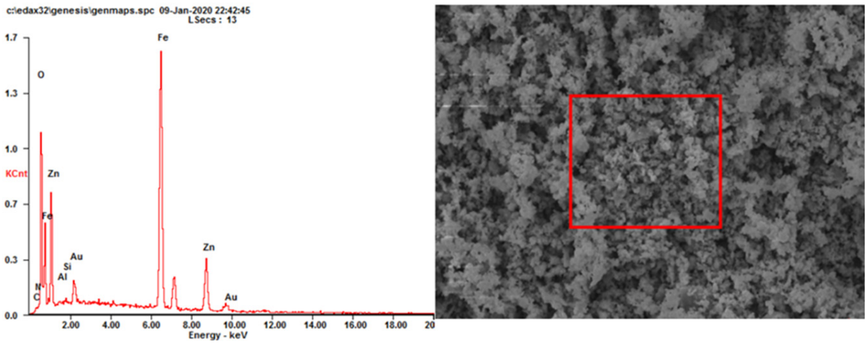


Fig. 7 EDS diagrams of purified zinc ferrite product of sample 1

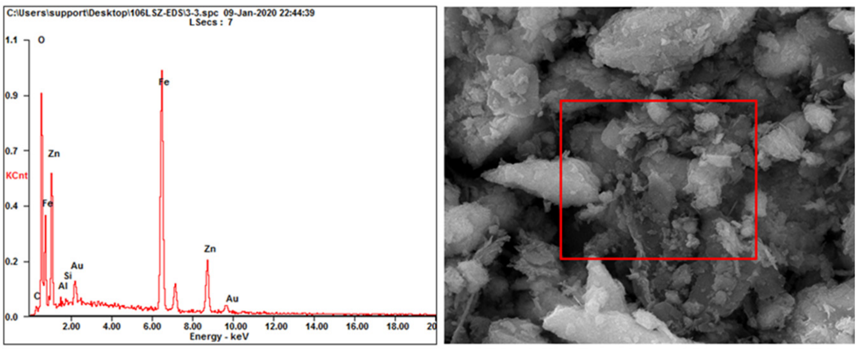


Fig. 8 EDS diagrams of purified zinc ferrite product of sample 2

4. Conclusions

(1)The XRD diffraction peaks of low content zinc ferrite products are more complex and have more impurity peaks than those of high content zinc ferrite products and less impurity peaks. The XRD patterns of leaching residue have little difference after sulfuric acid leaching purification, but the high content zinc ferrite products have higher crystallinity, the diffraction peak of zinc ferrite from leaching residue is stronger. That is to say, the content of zinc ferrite in the roasted product will not affect the final purification effect by sulfuric acid leaching purification. The phase composition of the purified product is similar, which the main component is zinc ferrite, and contains impurities such as gangue minerals.

(2)The adsorption-desorption curves of two purified zinc ferrite products are of type III, but the curves of two products are different. The specific surface area of sample 1 is 9.66 times that of sample 2. The Pore volume and average pore diameter are 8.14 times and 1.97 times, respectively. Therefore, the purified zinc ferrite products with low content of zinc ferrite will have more application potential as adsorbents.

(3)There are relatively few soluble impurities in the high content zinc ferrite products, so the micro-morphology of the samples has little change after leaching. However, there are more soluble impurities in the low content of zinc ferrite. After leaching purification by sulfuric acid, the position of the soluble impurities becomes pore, the large particles are decomposed and the particles become finer.

Acknowledgements

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