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Studies on the Synthesis and the Structure of Ferric Aluminum Magnesium Hydrotalcite-like Compounds

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Abstract: The particles of ferric aluminum magnesium hydrotalcite-like compounds (Fe-Al-Mg_HTlc) were synthesized by co-precipitation method. It was found that when n(Fe)/n(Al+Mg+Fe)<0.30 and n(Al)/n(Al+Mg+Fe)<0.30, pure HTlc can be formed; when the molar ratio of Al/ (Fe+Al+Mg)>0.30, $Al(OH)_3$ will emerge; when the molar ratio of Fe/(Fe+Al+Mg) >0.30, the amorphous composition will appear. Hence Fe^{3+} and Al^{3+} have no concentration superposition effect on the crystal structure of the samples.

Keywords: Hydrotalcite-like compounds, co-precipitation,synthesis.

Hydrotalcite-like compounds (HTlc) are composed of trivalent and divalent metal ions, the general formula [1] is:

$$[M^{2+}_{1-x}M^{3+}_{x}(OH)_2]^{x+}A^{n-}_{x/n} \bullet mH_2O$$

M^{3+} is trivalent metal ions, $M^{2+}$is divalent metal ions, A is negative ions whose valence is –n, and m is the amount of water in the crystal, and x is the molar ratio of trivalent metal ions to all metal ions.

A lot of studies have been done on the synthesis and property of HTlc, which is made up of two kinds of the metal ions. It has been found that the molar ratio of M^{3+}/M^{2+}can influence the crystal structure[2-4]. When $0.20 \leqslant M^{3+}/[M^{3+} + M^{2+}] \leqslant 0.33$,(or $0.20 \leqslant x \leqslant 0.33$), pure HTlc samples can be formed. When the value of x exceeds this limitation, the mixture of HTlc and according metal hydroxides could be gained [4]. Is this law suitable for the HTlc , which composed more than three kinds of metal ions ? Answer of this problem has not been found. Studying on the synthesis of Fe-Al-Mg-HTlc, we found that this law was not suitable for the preparation of Fe-Al-Mg-HTlc. The crystalline state and chemical composition of the samples acquired by X–Ray owder diffraction analysis and automatic X-Ray fluorescent spectrometric analysis are listed in **Table 1**. From the **Table 1** we can conclude that when x> 0.33, whereas n(Fe)/n(Al+Mg+Fe)<0.30 and n(Al)/n(Al+Mg+Fe) <0.30, pure HTlc still can be gained (see entries 5 and 6). In addition, when the relation between crystalline state, chemical composition and the ratio of n(Fe)/n(Al+Mg+Fe), n(Al)/n(Al+Mg+Fe) was analyzed carefully, it could be seen that only when n(Fe)/n(Al+Mg+Fe)<0.30 and n(Al)/

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n(Al+Mg+Fe)<0.30, the pure HTlc could be formed. The diffractive peak of $Al(OH)_3$ would appear when n(Al)/n(Al+Mg+Fe) >0.30(see entries 1,2), and amorphous composition would emerge when n(Fe)/n(Al+Mg+Fe) >0.30(see entries 3,4). When the influence of Fe^{3+} and Al^{3+} on the crystalline state was considered, there is no concentration superposition effect. Whereas we found that Zn^{2+} and Mg^{2+} have concentration superposition effect in the synthesis of Zn-Mg-Al-HTlc[5].

Table 1 Chemical composition and phase analysis of Fe-Mg-Al-MMH

Sample No.	Sample composition	x	n(Fe):n(Fe+Mg+Al) Sample	n(Al):n(Fe+Mg+Al) Sample
1	HTlc+$Al(OH)_3$	0.38	0.080	0.309
2	HTlc+$Al(OH)_3$	0.50	0.161	0.343
3	amorphous	0.64	0.462	0.180
4	amorphous	0.66	0.437	0.217
5	HTlc	0.35	0.140	0.215
6	HTlc	0.51	0.268	0.244

Sample formula: **1.** $Fe_{0.26}Mg1_{.98}Al(OH)_{7.0}Cl_{0.74}$; **2.** $Fe_{0.47}Mg_{1.45}Al(OH)_{6.95}Cl_{0.36}$; **3.** $Fe_{2.56}Mg_{1.98}Al(OH)_{13.34}Cl_{1.3}$; **4.** $Fe_{2.00}Mg_{1.58}Al(OH)_{9.71}Cl_{2.45}$; **5.** $Fe_{0.65}Mg_{3.00}Al(OH)_{10.2}Cl_{0.74}$; **6.** $Fe_{1.10}Mg_{2.00}Al(OH)_{9.60}Cl_{0.70.}$

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