

# Flame retardant mechanism and surface modification of magnesium hydroxide flame retardant

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**Abstract.** At present, a polymer material, as a representative of the fine chemical industry rapid development, promote the additives research and development process. Magnesium hydroxide flame retardant agent has green environmental protection low cost advantages, received more and more attention. Many countries use magnesium hydroxide as a name retardant instead of halogenated name retardant. Magnesium hydroxide has low fire retardant efficiency, it can achieve flame-retardant effect under large filling volume and then seriously deteriorate mechanical and processing properties of materials. In order to improve mechanical property of materials, and we must modify the surface properties of magnesium hydroxide. There have been researches about magnesium hydroxide surface modification, which normally applied surfactants or coupling agents as surface modification instead of not macromolecular surface modifiers. Increasingly becoming the focus of flame retardants research at home and abroad, magnesium hydroxide as flame retardant additives is easy to reunite dispersion such poor compatibility. Therefore, it's an important inquisitive task to improve the surface properties.

## 1. Introduction

Nowadays, the polymer materials industry has been rapidly developed. As a synthetic material, plastics, rubbers, fibers and the like are widely used in the fields of construction, chemical engineering and military. However, most of these polymer materials have the problem of easy combustion and thus lead to the number of major fires is increasing, so the application of flame retardant technology in these fields in the world is attracting much attention.

Today, the domestic and foreign production of flame retardants has made great strides, including a variety of organic and inorganic flame retardants. However, some flame retardants also have problems, which may have negative effects, such as the toxicity of the flame retardant itself or the release of harmful substances when used as a flame retardant. Therefore, the pursuit of a pollution-free and green environment-friendly flame retardant, this concept is also in line with the growing awareness of environmental protection. The 21st century is an era of technological innovation and green. Green is the development direction of flame retardants. More and more widely used as an efficient, low toxicity, smokeless, pollution-free inorganic flame retardants. Developed countries use a large proportion of inorganic flame retardants, and their share of high [1].



## 2. Magnesium hydroxide flame retardant

Magnesium hydroxide (MH) is a white solid powder with a chemical formula of  $Mg(OH)_2$ , a relative molecular weight of 58.33, a density of  $2.39\text{g/cm}^3$  at normal temperature ( $25^\circ\text{C}$ ). When the solubility of  $0.0009\text{g}/100\text{mL}$ , less soluble in a concentration of  $1\text{mol/L}$  aqueous solution of sodium hydroxide, but soluble in a strong acidic solution [2].

The majority of magnesium hydroxide is hexagonal or amorphous flake with a specific surface area (BET) $>20\text{m}^2/\text{g}$ . It is easy because of its large specific surface area, which leads to strong agglomeration between grains. Agglomerate to form particles with the particle size of  $10\sim 100\text{nm}$ , thereby creating a large gap at the interface of the polymeric material, resulting in serious defects at the interface, resulting in that the polymer cannot be dispersed in the polymeric material and the material activity is decreased to achieve the flame retardant effect.

Magnesium hydroxide flame retardant efficiency is not high, so to do with higher purity flame retardant use. China's magnesium hydroxide specification (HG / T3607-2000) is,  $MgO_2 \geq 63\%$  (Type I),  $Mg \geq 62\%$  (Type II), but to be used as a flame retardant indicators,  $Mg \geq 64.1\%$ .

In addition, the specific surface area of magnesium hydroxide should be less than  $20\text{m}^2/\text{g}$  to have a flame retardant effect, the United States Zeroed and Japan's Kisumu's surface treatment of magnesium hydroxide sold in the market, the specific surface area of the flame retardant index:  $15\text{m}^2/\text{g}$  and  $4\sim 7\text{m}^2/\text{g}$ .

## 3. Flame retardant mechanism of magnesium hydroxide

Magnesium hydroxide endothermic degradation dehydration reaction is:



The results show that the mechanism of flame retardancy and smoke suppression of  $Mg(OH)_2$  is mainly achieved by the following aspects [3]: ①Hydrolyzed to obtain crystal water, absorbing a large amount of heat ( $44.8\text{kJ}/\text{mol}$ ). From the decomposition of the initial temperature of  $340^\circ\text{C}$  to  $490^\circ\text{C}$  when completely decomposed, it is good to inhibit the temperature rise of the polymer, and prevent combustion; ②Decomposition products of Mg corresponding to the formation of stable oxide protective film, good fire resistance, covering The surface of the burning material, cannot contact with oxygen, cannot heat transfer; ③Generate a large amount of water vapor, reducing the concentration of combustibles in the gas phase zone; ④Water vapor does not participate in combustion of water vapor reaction.

It can be derived from the equation that magnesium hydroxide decomposes without the formation of harmful substances. At the same time can also be neutralized acid gas to achieve flame retardant. Magnesium hydroxide while enhancing the rigidity of polymer materials, abrasion resistance and so on. Overall analysis, magnesium hydroxide become more perfect environment-friendly flame retardant.

## 4. Research Progress of Magnesium Hydroxide Flame Retardant

As previously analyzed, magnesium hydroxide flame retardant is a near-perfect environment-friendly flame retardant, and has a flame retardant, smoke suppression, filling and so on. Magnesium hydroxide in many ways than its same type of aluminum hydroxide flame retardant dominant. But not always optimistic, there are many problems in practical application.

The most important, magnesium hydroxide as a flame retardant high requirements: the crystal structure is a large crystal type, low specific surface area, and low microscopic strain. However, the common magnesium hydroxide tends to have the opposite disadvantage. Therefore, its production process is particularly important, requiring low cost and good flame retardancy. Now, many people are keen on the synthesis of magnesium hydroxide preparation process in-depth study, the preparation process greatly optimized. Such as Li Zhengzheng, Li Shanxi and so on several different methods of

magnesium hydroxide preparation and improvement measures; Li Jun, Tang Goya by direct precipitation method, uniform precipitation method, reverse precipitation method and the preparation of Nano-magnesium hydroxide Of the process; Beijing University of Aeronautics Li Zhejiang with magnesium chloride and ammonia reaction can be synthesized at room temperature magnesium hydroxide hydrothermal treatment, the synthesis of magnesium hydroxide particles regular rules; Zhang Lining also studied the hydrothermal modification of the hydroxide Magnesium morphology; mineralization agent and the addition of CaCl<sub>2</sub> on the hydrothermal modification of the crystal growth direction of the impact of Lin and Wu QL were studied. Currently, there are now hydrothermal modification equipment is complex, expensive, conditions require higher, difficult to achieve industrial production, and thus the hydrothermal reaction is not applied. In addition, Wu JM et al [4] synthesized water-in-oil micro emulsion with good dispersion of Nano-Mg (OH)<sub>2</sub> particles and achieved the rules; An DM[5] et al., Dong HB[6] et al. In the synthesis process, magnesium hydroxide particles with good properties were synthesized by direct addition of modifier. The results of the preparation of magnesium hydroxide particles with an average particle size of about 100 nm by ion exchange resin were from Feng Chong and Yang Min. It can be seen from the above research results that the process of the crystallization reaction of magnesium hydroxide can be controlled within a certain limit according to the actual needs and the magnesium hydroxide with good flame retardancy is finally obtained.

Magnesium hydroxide, on the other hand, needs to achieve high flame retardancy and must be filled up to 60 wt. % or more. The flame retardancy of the polymer is greatly improved with the increase of the filling amount of magnesium hydroxide. However, there is a problem that magnesium hydroxide is more difficult to be contained with organic resins, resulting in insufficient mechanical and mechanical properties of the material. Such as a substantial reduction in elongation at break, tensile strength and impact strength are decreased, the material processing fluidity has also been destroyed.

Also, magnesium hydroxide powder has the advantages of high surface polarity, and a large number of hydroxyl groups, so it has a very strong hydrophilic, the performance is characterized by hydrophilic lipophilicity. Magnesium hydroxide has the disadvantage of having a high surface energy. Therefore, it is necessary to lower the surface energy in conjunction with the surrounding fine particles so as to form a relatively stable state of agglomeration to form the secondary particle diameter of 10 to 100 μm as mentioned above, resulting in flame retardancy of the particles. Reunion mechanism Li Xiao-kun, Zhang Hong conducted a thorough analysis. Superfine powder agglomeration Liu Halo, Cain Lingui and other detailed induction.

However, to achieve the true requirements of flame retardants, magnesium hydroxide should be carried out in several ways.

Magnesium hydroxide surface modification: Magnesium hydroxide has the characteristics of the surface properties of hydrophilic oleo phobic, high surface energy and so on, so filling into the material leading to deterioration of the material properties, so to deal with magnesium hydroxide to change its surface properties, Use surface modifiers. Magnesium hydroxide flame retardant in the organic resin compatibility and dispersion improved. Changing the surface properties reduces the aggregation tendency of the ultrafine particles, thereby enhancing the stability, prolonging the shelf life, and stabilizing the dispensability in the matrix.

Another method is to use magnesium hydroxide in combination with other flame retardants. The advantages of synergistic use in flame retardant technology are as follows: ①More effective flame retardant systems can be produced; ②The amount of chemical reagents in other flame retardants can be reduced; ③Improve the flame retardant flame retardant efficiency. The advantages of all flame retardants in one, the formation of complementary advantages. Cu Chinghai, Wang Wanxun, Li Honiara, respectively, on the synergy and cooperation with the use of in-depth study. The results show that the improvement of the flame retardant properties is related to the use of the composites. In this regard, Li Yangquan Nano-magnesium hydroxide composite system on the flame retardant properties of LDPE made a profound study, and verify the conclusion.

## 5. Study on Surface Modification of Magnesium Hydroxide

Powder solid surface modification, you can use physical, chemical, mechanical and other methods of powder particle surface treatment. According to the actual needs of the direction to change its physicochemical properties, such as surface crystal structure and functional groups, surface wettability, electrical properties, surface energy, and surface adsorption and reaction characteristics [7].

Magnesium hydroxide surface modification methods are diverse, according to the different treatment time can be divided into three categories: ①In the magnesium hydroxide synthesis process of preparation by adding surface modification directly modified so that the good performance of magnesium hydroxide dispersion. Thereby mixing with the polymer matrix to obtain a stable composite material; ②Firstly preparing the magnesium hydroxide powder and then modifying the surface with the polymer matrix; ③Mixing the magnesium hydroxide, the surface modification. The agent and the polymer resin matrix three kinds of direct mixing material, directly to the composite material. The third method is Wang Zhengzhou prepared modified MH / LDPE composite method, the advantage is that the process is simple and convenient, but the effect is indeed not as good as the first two modified methods.

Now most of the second method is to use modified magnesium hydroxide, and then complex with the polymer matrix. A large number of experiments prove that this method is the most effective.

## 6. Conclusion

Magnesium hydroxide flame retardant as a green flame retardant identity, it will have a lot of room for development, the future of the flame retardant polymer materials will also be more and more widely applicable. However, due to the low efficiency of magnesium hydroxide flame retardancy, in order for the material to achieve the standard of flame retardancy, we can only increase its addition, while the material oxygen index to meet the requirements, but the results have seriously deteriorated the mechanical properties of the material performance. Therefore, the surface modification of magnesium hydroxide has become one of the most crucial ways to solve this problem. Surface modification can effectively solve the problem of poor compatibility with polymer materials, which is of great significance to practical application. Choosing the right surface treatment is important to improve the performance of certain flame retardants. Magnesium hydroxide as a future with broad prospects for the development of inorganic flame retardants should arouse the attention of researchers. We need to speed up the surface modification of magnesium hydroxide, in particular, focus on the development of new surface modification agents, in-depth understanding of modification mechanisms continue to try new modification methods (such as microcapsule technology) to try to improve its compatibility with polymer materials dispensability and compatibility. Only through the continuous improvement of the flame-retardant magnesium hydroxide, smoke suppression performance, and thus the application of magnesium hydroxide flame retardants will be more widely developed.

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