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Modification of Nano Tourmaline Surface Treatment Agent and Its Performance on Negative Ion Release

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Abstract: In this paper, a kind of wall fabric's surface treatment agent modified with nonionic surfactant was reported. This surface treatment agent was prepared by using nano tourmaline powder dispersion in water with surfactant as dispersants by sand milling. Under the influence of different dispersants, the negative ions releasing amount of functional wall fabrics, the milling process and the storage stability of nano tourmaline powder dispersion were discussed. The results showed that nano tourmaline powder dispersion achieved the smallest average diameter of 44 nm and had best storage stability that the average diameter maintained below 200 nm in 17 days when the addition amount of dispersant was 20 percent of the tourmaline powders' weight. What is more, the quantity of negative ion releasing achieved 6500 ion/cm^3 when addition amount of dispersant was 30 percent. This technique could be used to strengthen productivity of nano tourmaline powder dispersion.

Keywords: Tourmaline, dispersant, negative ion, storage stability, wall fabrics.

1 Introduction

The modification of household textiles materials is always the research hotspots in the textile field [Hernandez, Nowack and Mitrano (2017); Mitrano, Rimmele, Wichser et al. (2014)]. To urmaline had been widely used in textile products because of the characteristics of releasing negative ions. There had many methods to add the tourmaline to the household textiles. For example, the electrostatic spinning method could attach the nano powder to nanofiber fast and firmly [Fong, Liu, Wang et al. (2002); Qu, Wang, Jiang et al. (2014)], which also restricts the amount of negative ion release. The low cost finishing agent method [Lan, Ma, Li et al. (2016)] has the defects of easy to drop powder for a long time. However, it could give full play to the negative ion release capacity of tourmaline. Scholars also studied new adhesives that strengthen the attachment between nanoparticles and fibers [Cao and Andrey (2016); Xing, Zhong, Xu et al. (2010)], which made the finishing agent method more operational. In the process of large production, the storage of the finishing agents had become a new problem. An effective way is to use dispersant increase the stability of inorganic nanoparticles in solution [Metin, Lake, Miranda et al. (2011)], sometimes by using silane coupling agent [Abdelmouleh, Boufi,

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Belgacem et al. (2007); Yang and Thomason (2013)] before treatment. In addition, combining the mechanism of negative ion generation, selection of high HLB value of dispersant could increase the negative ions quantity.

2 Materials and methods

2.1 Materials

Tourmaline powder was purchased from Hebei Lingshou Mineral Co. Ltd. and used as received. Wall fabrics were purchased from Jiangsu Tengsheng textile Industry Group. Dispersants (PEG4000/A115/O15) were purchased from Jiangsu Haian petrochemical plant. Adhesive (agent A) were purchased from Shanghai NaNo Colloid Co. Ltd.; Other materials was purchased from commercial suppliers and used without further purification.

2.2 Test

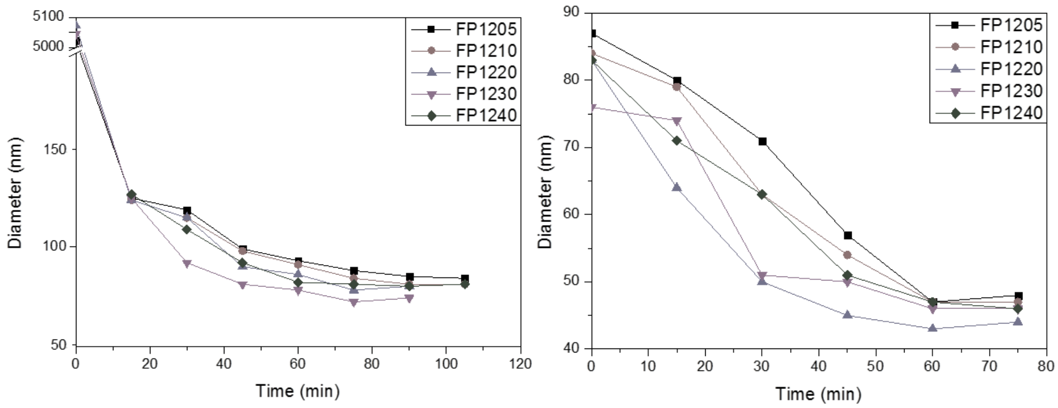
Using Laser Grain Size Analyzer (Mastersizer 2000, Malvern Co. Ltd.) measured the size distribution of tourmaline particles; the method of the negative ions amount test was based on the People's Republic of China Building Material Industry Standard JC/T 1016-2006 "Testing on negative ion concentration of materials" to control the environmental conditions with temperature at 23±1℃ and relative humidity at 50±5% using Air ions counter (COM-3600F, Japanese com-system Co. Ltd.)

3 Result and discussion

3.1 Sand milling process of nano tourmaline dispersion

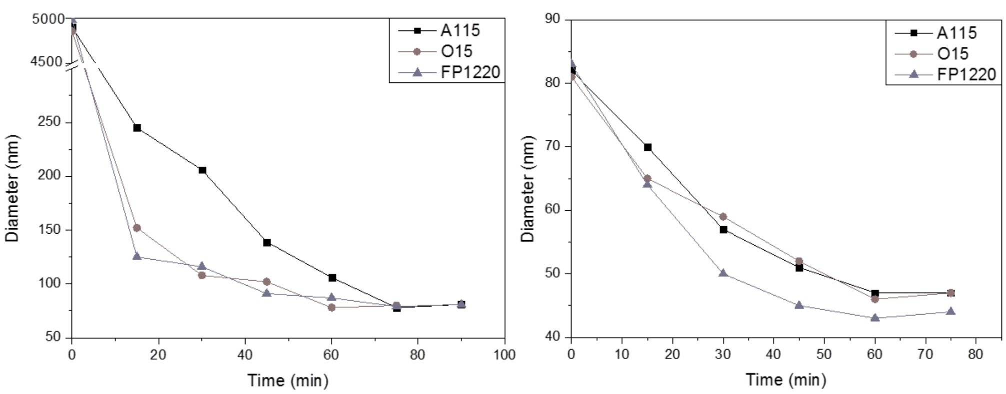
Tourmaline powder was mixed with PEG4000 (DP) and water in different ratio to make initial dispersion. According to different addition amount of DP, five samples were named FP1205, FP1210, FP1220, FP1230 and FP1240 (the number 05, 10, 20, 30, 40 is by wt% based on the tourmaline, for example, FP1205 means the Tourmaline/DP/water wt%=12/0.6/87.4). In order to protect machines, initial dispersion was prepared through two processes including rough sand milling with 0.4 mm zirconia and finishing sand milling with 0.2 mm zirconia. Processing would not stop unless the particle average diameter (d50) no longer declined.

Fig. 1 shows the relationship of particle size and process time using DP in five proportions. When the rough milling time is up to 85 min, FP1230's d50 decreased to 75 nm. When the finishing milling time is up to 75 min, FP1220 got a smallest d50 of 44 nm. 20% was chosen as the addition value of A115 and O15 to compare the impact of different kinds of dispersant (DP/A115/O15) on d50. The result was showed in Fig. 2. FP1220 still got the best performance.



A **B**

Figure 1: The relationship of diameter and rough milling time(A)/finishing milling time(B) using DP in five proportions



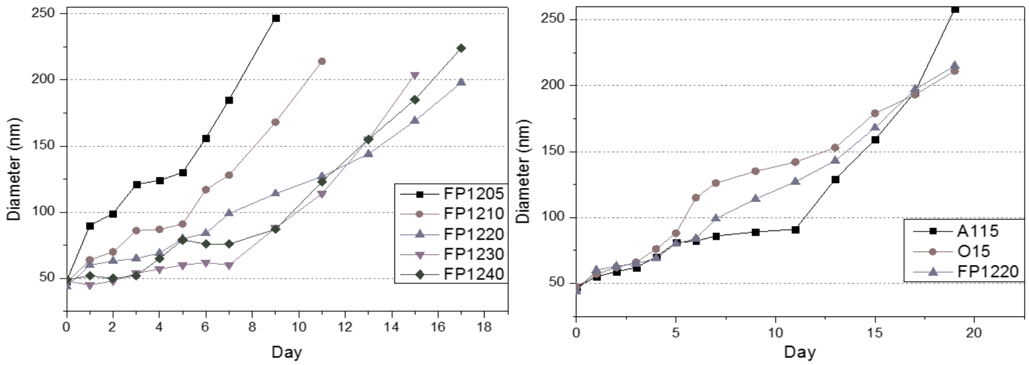
A **B**

Figure 2: The relationship of diameter and rough milling time(A)/finishing milling time(B) using A115/O15/DP in 20%

3.2 Storage stability of nano tourmaline dispersion

The seven nano tourmaline dispersions abovementioned were sampled and their particle sizes were measured periodically. For the convenience of comparison, 200 nm was set as a highest acceptable standard. Fig. 3 shows the relationship of d50 and storage time using DP in five proportions (A) and A115/O15/DP in 20% (B). Sample FP1220 had a longest storage time of 17 days. The samples A115/O15 had the nearly same result.

Fig. 4 shows the particle diameter distribution of FP1220 in storage 1 day (DAY1, 44 nm), 3 days (DAY3, 65 nm), 9 days (DAY9, 104 nm) and 17 days (DAY17, 197 nm). The graph of DAY3 indicated that there had been some tourmaline particle of large diameter began to form. At 17th day, only about 50% of particle was kept below 100 nm.



A **B**

Figure 3: The relationship of diameter and storage time using DP (A) and A115/O15/DP (B)

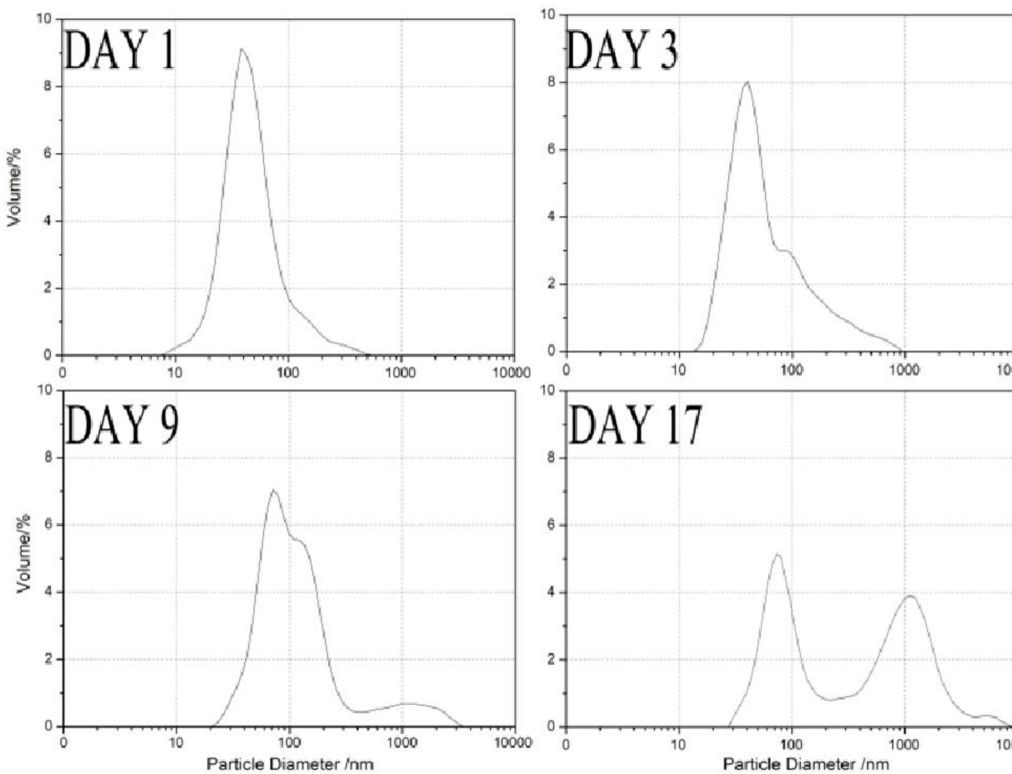


Figure 4: The particle diameter distribution of FP1220

3.3 Negative ions quantity of functional wall fabrics

For the convenience of dipping operation, initial dispersions were mixed with adhesive (the addition value is 1 wt% based on finishing agent) and extra water to get the negative ion finishing agent (Tourmaline/DP/Agent A/ water wt%=6/0.3/1/92.7).

Fig. 5 shows the negative ions quantity of 8 kinds of wall fabrics. DP was expected to improve the storage performance. However, by force of contrast of NP (without DP) and other simples, DP obviously increased the negative ions quantity. At the same concentration, PEG was slightly better than A115 and O15. The negative ions quantity would increase by increasing DP's addition and the best amount was 30%.

Nevertheless, the end product was found to have an excessively humid feeling of hand touching. Tab. 1 dedicated the main parameters of 3 dispersants. The high HLB value of PEG caused a better hydrophilicity, which can explain the sense of moisture. The high negative ion amount of PEG samples could be explained by the mechanism of the negative ion. The hydrophilicity of A115 and O15 was slightly worse, but it still significantly increased the number of negative ions. From the practical point of view, it could be used as a substitute for dispersant.

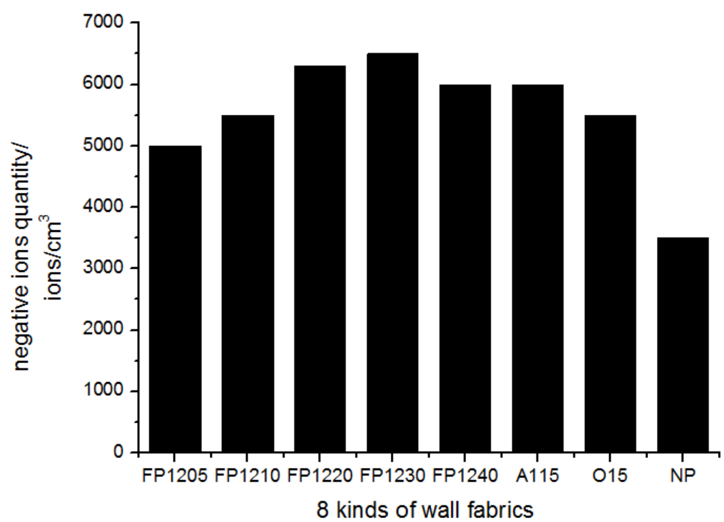


Figure 5: The negative ions quantity of 8 kinds of wall fabrics

Table 1: Main parameters of PEG4000/A115/O15

Nature	PEG4000	A115	O15
PH value (1% aqueous solution)	6-8	5-7	5.5-7
Hydroxyl value (mgKOH/g)	25-32	55-65	57±4
HLB value	20	14	14-15

4 Conclusion

Nano tourmaline surface treatment agents (tourmaline content 12 wt%, PEG4000 content 20 wt% of tourmaline) were prepared. The average particle size of tourmaline in the surface treatment agent is 44 nm and held the level below 200 nm for 17 days. The functional wall fabrics treated by this surface treatment agent showed great performance in high negative ions releasing ability. Through a reasonable treatment process, the released amount reached 6500 ions/cm^3.

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