# Application of Smectite to Dyeing

**Jong-sun Jung, Motoko Komaki, Teiji Sato ***

Doctoral Research Course, Ochanomizu University
Otsuka 2-1-1, Bunkyo-ku, Tokyo, 112-8610, Japan, E-mail: jung.jongsun@gmail.com
* Kurosaki Hakudo Industries Co.,Ltd, Odo 2331, Shibata-shi, Nigata

## 1. INTRODUTION

It is found that mud can color cotton fabric firmly, and the smaller the clay particles constituting the mud, the better the coloration [1]. The component of micro scale particles might be smectite and iron oxide. As smectite is ion-exchangeable on the basis of a net negative charge, cationic materials can be inserted between its layers.

In this report it is studied to make pigments by intercalating cationic dyes into smectite layers and to improve washing fastness and light fastness of cationic dyeings by aftertreating with smectite.

## 2. EXPERIMENTAL

2-1. Samples

1) Smectite (Kurosaki Hakudo Industry Co. Ltd.)
 * Raw clay smectite (8.17μm in average particle diameter) (S)
 * Refined smectite (1.43μm in average particle diameter) (S Ⅱ)
2) Cationic dyes (Wako chemical reagent (special grade))
 * Berberine Chloride n-hydrate (abbreviated as Be)
 * Methylene Blue trihydrate (abbreviated as Me)
 * Rhodamine B (abbreviated as Rh)
 * Crystal Violet (abbreviated as Cry)
3) Fabrics
 * Cotton fabric: plain weave # 2023 (Kanebo)
 * Wool fabric: Muslin (Nakao filter)
 * Silk fabric: Fuji silk (Kanebo)

These are scored and bleached without optical brightener.

2-2.Preparation (intercalation) of smectite-pigment (PDS)

 * Clay slurry (85 g) including 20.0 g of raw clay smectite was add to 215 g of water at 70 ℃ (liquid A).
 * 10.0 mmol of each dye was dissolved into 200 g of de-ionized water at 70℃ (liquid B).
 * Liquid B was slowly dropped into liquid A at 70 ℃ during 30 minutes and then the reactant was stirred by 300 rpm for one hour at 70 ℃.
 * The obtained substance was filtered using cellulose filter paper (No. 2). The precipitate was washed with 100 ml of water, twice at 50-70℃ and three times at room temperature respectively.
 * The substance was dried for 24 hours at 35℃ and then crushed in a mortar.

2-3. Finishing method

a) Dyeing with cationic dyes (method (a))
 Three kinds of fabrics were dyed with 2% owf of four dyes respectively with 1:50 of liquor ratio at 80℃ for 60 minutes under 100 rpm agitation.
b) Coloring with smectite- pigments (method (b))
 The fabrics were treated with 2% owf of dye in the pigment under the same conditions as dyeing with cationic dyes.
c) Aftertreatment of cationic dyeings with smectite (method (c))
 The fabrics were dyed at first with each cationic dye under the same conditions as method (a) and then treated with smectite. One g of dyed cloth was agitated in 100 g of liquid A at 70℃ for 30 minutes.

※ Rinsing was done three times with 100ml of water in each case.

2-4. Measurement

* XRD analysis was performed by Powder X-ray diffraction device (MultiFlex, Rigaku, Corp)
* *K/S* spectrum calculated from the surface reflectance of the finished cloths measured by Spectro photometer NF777 (400-700nm, Nippon Denshoku Kogyo)

2-5. Color fastness test to washing

* Washing test was carried out according to JIS L 0844 (1986) *Color Fastness Test to Washing* at 40±2 ℃ for 30 minutes.

## 3. RESULTS AND DISCUSSION

3-1. The XRD analysis of smectite-pigments

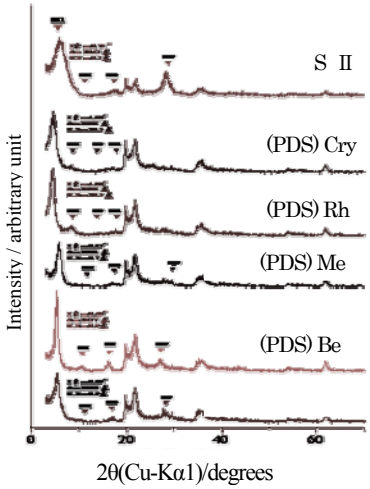


Fig.1 The XRD profile of smectite-pigmnets (PDS)

Four smectite-pigments made of raw smectite (S) and cationic dyes were analyzed and compared to original smectite (S, S Ⅱ) by XRD (Fig.1). In each case of four kinds of PDS, the interlayer spaces calculated from the position of diffraction peaks of face (001) were different from the size of dye molecules. It means that the intercalation has been successfully carried out.

3-2. Characteristics of coloring and washing resistance by three methods of a, b and c

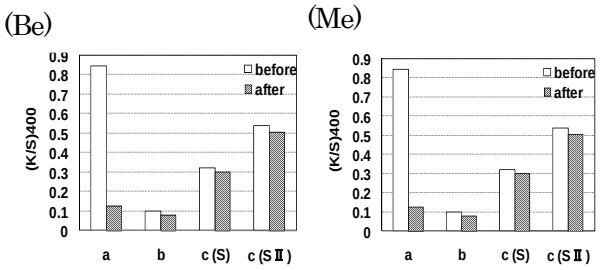


Fig.2 Effect of washing on *K/S* of the cotton cloths colored with Berberine (Be) and Methylene Blue (Me) by three methods (a,b,c)

The *K/S* values at 400 nm of the cotton fabric treated by three finishing methods and washed are shown in Fig.2. However the coloration of cotton fabric with cationic dye by method (a) was apparently quite successful, washing resistance was extremely low. The coloration by method (b) using a smectite-pigment (PDS) was not effective for cotton fabric. On the other hand, method (c), by which at first dyed cotton fabric by method (a) and followed by aftertreatment with smectite gave both good coloring and washing resistance. Particle sizes also affect the coloration of cotton fabric. The smaller of the diameter, the better the coloration ($(K/S)_S < (K/S)_{SII}$). The similar results was found from the other two kinds of cationic pigments (Fig . 3).

These effects by aftertreating the dyed fabrics with smectite were found not only for cotton but also for silk and wool cloths (Fig. 4).

It is not clear why the aftertreatment with smectite improve the washing fastness, because of producing the intercalation or coating effect upon the dye.

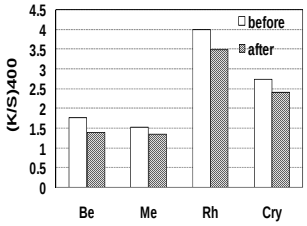


Fig.3 Effect of washing on *K/S* of cotton fabrics dyed with different kind of cationic dyes (Be, Me, Rh, Cry) and aftertreated with smectite (SII) by method (c ).

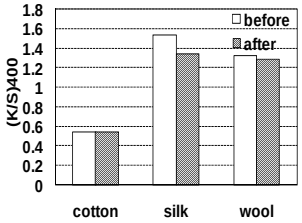


Fig.4 Effect of washing on *K/S* of different kind of fabrics finished with Methylene blue by method (c ).

## 4. CONCLUSION

1) Smectite-pigments were made of cationic dye and smectite by intercalation. It was not obtained deep color but good fastness to washing by finishing cotton fabric with the smectite-pigments.

2) The deep color and good fastness to washing were given by aftertreatment with smectite on cationic dyed fabrics. Especially, it was so effective on cotton fabric.

3) Coloration depended on the particle diameter of smectite used.

## 5. REFERENCE

[1] Jong-sun Jung, Motoko Komaki,, Fiber Science and Technology, Japan, Fiber preprints, 63(1), 242 (2008)