Properties of Coated Paper and Printabilities by Surface Modification of Pigments for Papermaking

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ABSTRACT

To improve the quality of coating paper, many areas, such as the manufacturing process of inorganic pigment for the coating, the property change of coating color, the surface design of coating pigment and the productivity of coated paper, were studied. In this study the physical properties and printability of coated paper were compared with the coating pigment to modify the surface of large particle and the coating pigment to mix together the large and small particles. After the coating color was mixed under the same conditions in order that the coating color has the same printability, the printability change caused by the surface modification of coating color was investigated. With the surface SEM of coated paper, the efficiency of the surface modification of coating pigment was investigated. The physical property and printability of coated paper, in addition to the physical properties of coating color, were compared and evaluated. Also, the efficiency of printability was evaluated, changing the mixing condition.

INTRODUCTION

The powder technology that comes to foundation of 21th century manufacture industry is expected that creates a new technology and industry demand over industry.
Technical development of functional powder is preceded harder in advanced country. But, domestic technological level is real condition that is achieving basic study at some university and research institute present. However, it is trend that demand about multi-functional powder of high added value is increasing continuously on latest our industrial society. So, to invent effective futurity industry, intensive research and development for vanguard multi-functional material development that can break through limit of existing powder property is preceded. Recently, surface modification technology of given attention to powder based on uniformity dispersion technology of particle surface of powder a technology that treated composition by electronic force and mechanical shock power.
In this research, wish to apply to inorganic pigment for paper coating with confirmed possibility through study finding of several times about field of paper application of a surface modification technology and evaluate efficiency of a surface modification technology. Pigment that occupy most of component parts of coating color causes great effect in properties of physics and optical properties of coated paper and print ability. This pigment influence electronic property of particle, particle size, particle shape in coating layer according to smectic formation and combination form. Usually, by particle TiO_2 that refractive index is high on surface of inorganic pigment been using in surface modification white of pigment itself and increase scattering degree. Properties of physics and optical property in coated paper of coating color that apply ability pigment, And supplement for existing inorganic pigment of paper measuring print ability finally. Also, is presenting design and basic data that can invent by composition particle that can give various ability allowing objective of this research.

Experimental

Surface modification of the inorganic pigment

In this experiment, used 3 kinds of No.1 clay, No.2 clay, talc been using to inorganic pigment for making paper usually by particle for surface modification of inorganic pigment. Use TiO_2 (rutile beam) by fine particle and displayed basic properties of matter of these pigment to Table 1.

Table 1, Properties of materials.

Powder	Species	Size(um)	Gravity[-]
Clay no.1	Ultra gloss E10®(Engel Hard, U.S.A)	1.8um	2.60
Clay no.2	Ultra gloss KL®(Engel Hard, U.S.A)	1.8um	2.60
Talc	Hydro gloss LV®(Huber, U.S.A)	2.1um	2.85
TiO_2	P-25®(Junsei, Japan)	0.21um	3.80

Manufacture of coating paper

Coating base paper used gram mage 70 g/m^2 acid free paper that make in domestic paper-making company.
Inorganic pigment 3types (clay no.1, clay no.2, talc) for coating that coating cosmetic is used usually as appear to Table 2 used inorganic pigment 6types that treated surface modification by standard and inorganic pigment 6types that mix simplicity. Used SBR latex (KSL-208, Kum ho) and CMC (Finnfix 5, Metsa) by backing binder by binder. Used air detraining admixture (PRONAL-208®, Woo Jin) to control dispersant (WJ-400®, Woo Jin) and bubble occurrence for dispersion of pigment by other admixture. Also, used 10% NaOH to control pH of coating color

Table 2, Pigment sample for coating.

No.	Condition	Ingredients	Blending ratio	Designation
1	Control	Clay no. 1	100	Control
2		Clay no. 2		
3		Talc		
4	Blending	Clay no. 1 + TiO_2	90 : 10	Blend A
5		Clay no. 1 + TiO_2	62 : 38	Blend B
6		Clay no. 2 + TiO_2	90 : 10	Blend A
7		Clay no. 2 + TiO_2	62 : 38	Blend B
8		Talc + TiO_2	90 : 10	Blend A
9		Talc + TiO_2	84 : 16	Blend B
10	Modification	Clay no. 1 + TiO_2	90 : 10	Modifi. A
11		Clay no. 1 + TiO_2	62 : 38	Modifi. B
12		Clay no. 2 + TiO_2	90 : 10	Modifi. A
13		Clay no. 2 + TiO_2	62 : 38	Modifi. B
14		Talc + TiO_2	90 : 10	Modifi. A
15		Talc + TiO_2	84 : 16	Modifi. B

Coating color made solid content concentration 55% dispersing by low speed stirrer after add binder and other admixture, and the mixing ratio is same Table 3. Spread to coating amount 10±1 g/m^2 dimension using auto blade coater since coated paper. And execute calendar transaction on term of surface temperature 60℃, pressure 500 psi and made coated paper.

Table 3, Coating color formulation.

	Ingredients	Parts on pigment 100
Pigment	Pigment	100
Binder	SB Latex	12
	CMC(Finnfix-5)	1.0
Additives	Dispersant(WY-117®)	0.2
	NaOH(10%)	0.1
	Deformer(PRONAL-208®)	a little

Properties of physics and print ability

Light scattering coefficient, brightness measured opacity, optical property of coated paper of CIE L.a.b (Elrepho 3300) and smoothness (Bekk type) and Sheet gloss(T-480A) according to tappi standard. Printability of coated paper measured ink receptivity, ink set-off, wet ink repellence and dry-pick, wet pick strength to use RI-II printability tester. Measured and estimate print gloss and print quality to use densitometer) and visual ranking after print.

Results and discussion

Surface modification of inorganic pigment

SEM pictures are presented in Fig 1 after mixing and surface modification of the clay no. 2 with TiO_2.
As shown in the picture, a surface modification of treated pigment was done better than that of primary samples, and TiO_2 is overall well-distributed. Picture of right is that display talc situation. Talc that particle size is big was not modified fine particle evenly on the core particle surface. This is thought that it is because electronic force adsorption energy between particles is smaller than clay. However, because surface residual percentage was high than in case of mixed TiO_2, was thought that talc is operating by surface modification operation.

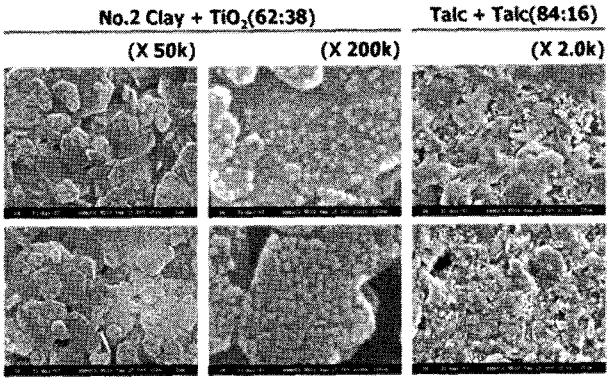

Fig. 1, SEM photographs of blending powder & modification powder.

Effect of properties coating color physics using surface modification pigment

Fig. 2 showed measuring viscosity of coating color make no.1, no.2 clay and talc by mixing ratio calculation.
Coating color use pigment and mixing pigment that surface modification viscosity appear lower than coating color use single type pigment. We know viscosity of coating color use pigment surface modification shows lower than occasion of mixing pigment.

Usually, occasion of clay and talc have conformation of plate form is big contact area between particle in coating color. However, when core particle surface modification with fine particle TiO_2 that particle size is small, was fallen relatively contact area between particles. Also, when surface modification, that uniformization and conglobation of particle at the same time surface modification are gone according as higher hybridizer's rotor turning speed (rpm) is thought standpoint of coating color affects in decline.

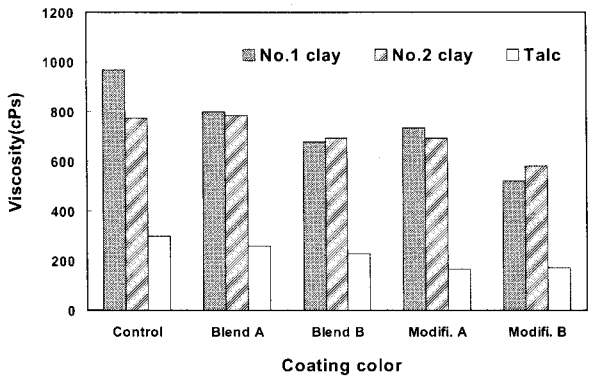

Fig. 2, Viscosity of coating color.

Light scattering coefficient of coated paper is made in surface modification pigment

Fig. 4 is TiO_2 light scattering coefficient of coated paper measured that is made in mixing and surface modification pigment measure. We could know that light scattering coefficient is improved according to composition rate of TiO_2 in Fig. 3. Light scattering coefficient calculated from optical properties and the coated rate using Kubelka-Munk. Basically, by high refractive index of TiO_2, light scattering coefficient of coated paper as well as pigment showed all increasing tendencies. In pigment used core particle surface modification with fine particle appears higher light scattering coefficient than mixed simplicity.

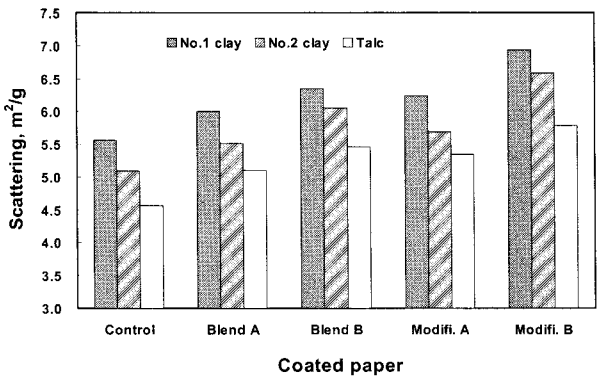

Fig. 3, Scattering coefficient of coated paper.

Opacity and brightness of manufactured coated paper

Measuring opacity of made coated paper appeared to Fig. 4. Display tendency that opacity increases mixing ratio of TiO_2 amount increases. Opacity of pigment that surface modification is showing higher numerical value than mixing pigment. However, is considered that do not become surface modification is effective opacity numerical value change with mixing pigment and modification pigment is low in occasion of talc.

The brightness of coated paper showed that brightness increase all similarly by TiO_2 (Fig. 5). In an experiment clay no.1 38pph's TiO_2 when surface modified, brightness of about 1.5% were improved when 0.5% displayed numerical value higher than (blend B) mix 38pph TiO_2. Lawrence L. Houle according to, as mixing ratio of TiO_2 increases from 0pph to 10pph if use gram mage 44.4 g/m^2's base paper, brightness of 3.7% increase.

But, agree with result that displayed 0.8 and 1.2% in case use base paper of review gram mage 66.6 g/m^2's and 96.2 g/m^2's. Through this, in case of the review base paper of lower gram mage uses brightness and opacity is more increased by surface modification with TiO_2.

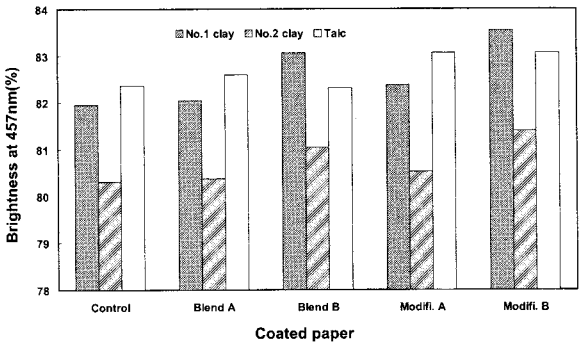

Fig. 4, Opacity of coated paper.

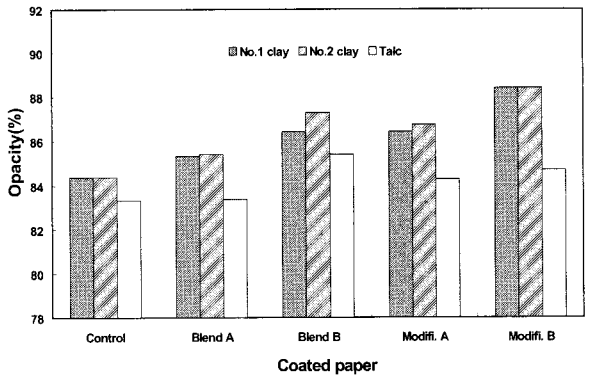

Fig. 5, Brightness of coated paper.

Sheet gloss and smoothness of manufactured coated paper

In the case of inorganic pigment, it is shape of pigment to affect greatly in sheet gloss. Fig. 5 is result that measured sheet gloss of made coated paper. If mix TiO_2 that is spherical small particle to core particle of plate shape of all as can know in picture mixing or surface modification, sheet gloss of coated paper was fallen according as mixing ratio increases. But, TiO_2 that decline of sheet gloss is reduced if do surface modification than mixing appear. TiO_2 was not distributed uniformly within coating layer in case of mixing. Because this may exist in big particle conformation that can be projected on the coating layer surface to aggregate between TiO_2, is thought that TiO_2 is fallen than occasion of surface modification pigment exist by ratio is fixed on the core particle surface. Smoothness is displaying aspect such as result of a previous experiment by interrelationship with sheet gloss (Fig. 6). Because that smoothness is not fallen in occasion of pigment that reform modification occurred uniformization of particle at the same time surface modification heightening rotor speed of revolution in hybridizer. Because clay no.1 was plate shape, was measured that smoothness of coated paper is not fallen relatively even if TiO_2 is compounded. Also, is thought that it is influenced in shape and size of pigment that difference of smoothness variation by kind of pigment occurs.

On the other hand, in the case of talc, vertically and horizontally ratio greatly but remarkably sheet gloss and smooth appear. Because talc is all of amorphous that is non ionic character unlike general inorganic pigment such as clay has hydrophobicity. This is amiss by manufacture of general coating color because dispersion has difficult special quality than other pigment. In this experiment, because made coating color in condition that is same condition coating color of clay, surface measures very rough shape make coated paper of talc displayed sheet gloss and smooth remarkably. However, evaluated that is improved by constant level by mixing and modification operation of TiO_2 that is corpuscle.

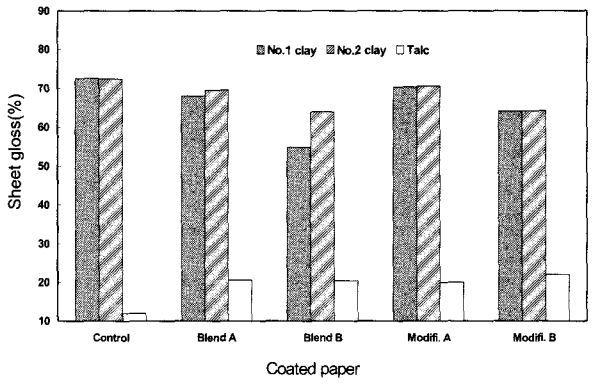

Fig. 5, Sheet gloss of coated paper.

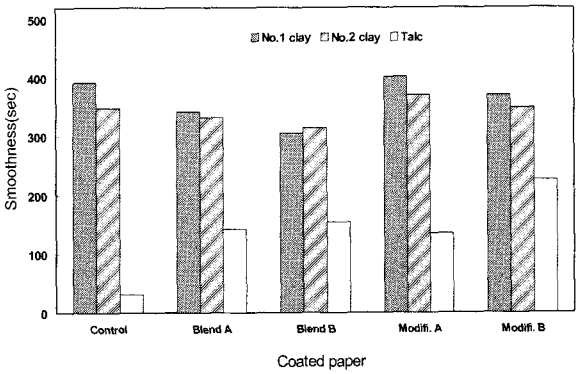

Fig. 6, Smoothness of coated paper.

Roughness and thickness

Fig. 7 is graphing that measure roughness of coated paper. Roughness is measured clay treated surface modification higher than clay of mixing, and in the case of talc, sample treated surface modification appeared low. Because TiO_2 is scattered well evenly on the clay surface, roughness of clay surface increased surface modification than general clay surface is considered. However, is considered from result data of printability that roughness of clay increase when is based does not exist. In the case of Talc, roughness of sample that treat surface modification decreased when compare with composite sample. This is considered talc that particle size is big that effect by this acts greatly to roughness because uniformization of particle and decrease of particle size at surface modification occur. Fig. 8 is graph that measured thickness of coated paper. Thickness appeared higher clay and talc that treated surface modification than both sample of mixing. Thus, TiO_2 has high specific gravity on the coating particle surface that thickness of coated paper decreases because treated surface modification. Finally, specific gravity of coating particle becomes high and is considered that compression density of powder is improved and influences in thickness decrease of coated paper. Is expected that these result can apply special ability powder as well as TiO_2 is more various and wide in paper making and printing business species treating surface modification on the coating pigment surface.

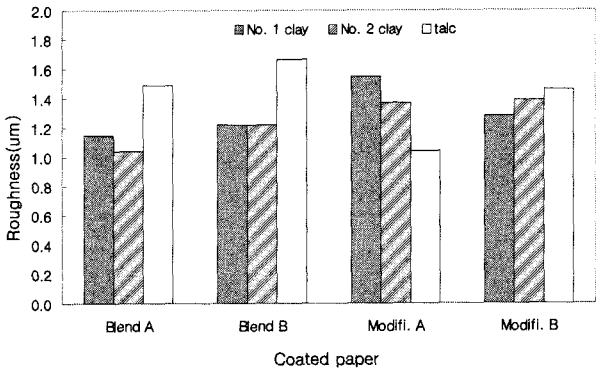

Fig. 7, Roughness of coated paper.

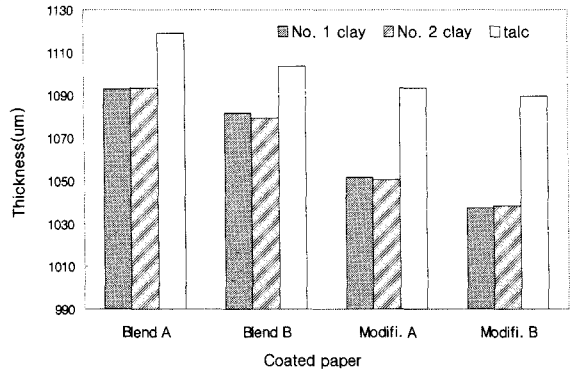

Fig. 8, Thickness of coated paper.

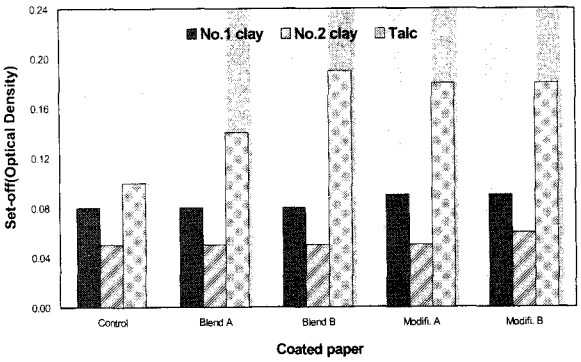

Fig. 10, Ink set-off of coated paper.

Printability of manufactured coated paper

Ink receptivity result is appeared to Fig. 9 of the sample picture and printing gloss. Ink receptivity occasion is displaying result that is improved a little by surface modified with TiO_2. In the case of ink receptivity, mixing of TiO_2 and difference of surface modification treatment were not observed into unaided eye and printing gloss value. However, optical concentration value can know that occasion of surface modification treatment displays value is low on the whole than mixing of TiO_2. This in occasion of surface modification treatment than mixing of pigment, coating layer does more bulky and path of ink can be permeated is procured relatively. Therefore, ink remain behind on the coating surface is of small quantity. Fig. 10 is result that is smear with ink to other side overlapping printed surface for appraise ink set off property by measured optical concentration. As a result, although clay did not display some change, talc could observe both mixing and surface modification treatment is fallen by addition of TiO_2. The particle size of talc is big relatively than clay can know that set-off appears clearly because permeation and dry of ink are delayed by small specific surface area. When dry-pick strength of Fig. 11 mixed TiO_2 core particle's shape or fine particle's additional ratio of unsettled numerical value appear. But, because TiO_2 remained behind evenly on the surface as can know if see SEM picture of surface modification pigment in occasion, dry-pick strength is improved greatly. Also, is appeared equal change in Fig. 12 that measure wet-pick strength by dampening.

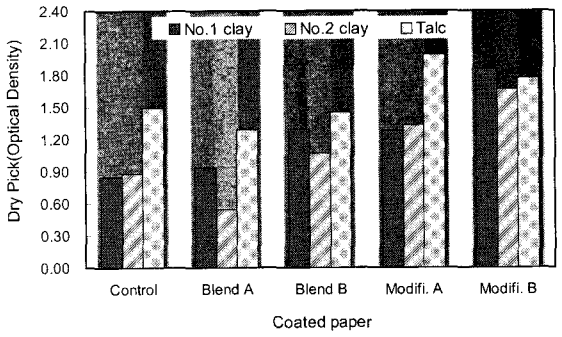

Fig. 11, Dry-pick of coated paper.

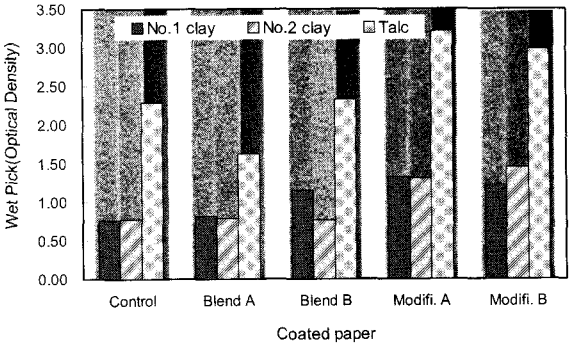

Fig. 12, Wet-pick of coated paper.

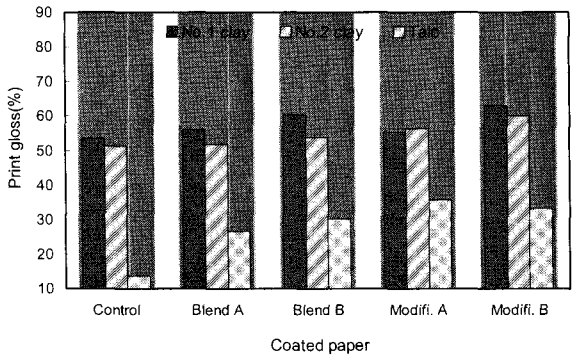

Fig. 9, Ink receptivity of coated paper.

Conclusion

In this research, confirmed following conclusion about properties of coated paper physics and printability by surface modification treatment of coating pigment. The physical properties and printability of coated paper were compared with the coating pigment to modify the surface of large particle and the coating pigment to mix together the large and small particles. The characteristics of the functional inorganic pigments are summarized as follows.

1) The measure properties physics of coated paper that make using surface modification pigments, light scattering coefficient, brightness and opacity of optical properties increased. In case of this apply low gram mage's base paper effect is enlarged by surface modification treated.

2) Result appear that surface property of inorganic pigment is fallen some according as modified with TiO_2 to inorganic pigment for coating. However, is considered that optical properties and printability of coated paper not influenced.

3) Printability of coated paper was made surface modification treated pigment is weak in set-off appeared, but relevant value is feeble and showed greatly in printability.

With the result of the study, we have achieved the reduction of production cost in making multi purpose paper in the research the scene application. Bring new model of coating pigment in terms of the surface reformation technology improving frailty of the powder property. These results are expected that can apply special ability sample as is more various and wide in paper making and printing business in addition to surface modify with TiO_2. Multi purpose pigment will play a key role in improving special paper making technology of paper industry.

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