

# APPLICATION OF ELECTRON BEAM CURING TECHNOLOGY FOR PAPER PRODUCTS



MY0001407

Takaharu Miura  
Specialty Products Development Laboratory  
Oji Paper Co., Ltd.  
1-10-6 Shinonome Koto-ku Tokyo 135-8558, Japan  
Phone +81-3-3533-7290  
Fax +81-3-3533-1837

## 1. INTRODUCTION

The electron beam(EB) curing technology has rapidly advanced in recent years. However there were few examples applying this technology to paper products. One reason comes from the high price of EB equipment and the other comes from the difficulty of controlling the irradiation which gives damages to paper. In spite of these problems, the EB cured coating layer shows remarkable features, such as solvent-resistance, water-resistance, heat-resistance and high smoothness using the drum casting technique. Concentrating on application of this technology to paper, we have already developed some products. For example, paper for printings (Super Mirror PN) and for white boards (Super Mirror WB) have been manufactured. In this presentation, we are going to introduce this EB curing technique and the products.

## 2. APPLICATION TO THE PAPER PRODUCTS

### 2-1 The difference from conventional method of coated layer formation

The characteristic of paper products using electron beam curing technology was shown in the table in comparison with a conventional heat drying coatings formation method.

	Conventional Method (Thermal )	Electron Beam Curing Method	
Drying time	Few sec.~few min.	Instantaneous	→ High Productivity
Processing Temp.	80 ~ 250°C	Room Temp.	→ Base Selection Free
Energy efficiency	100	2	→ Save Energy, Save Cost
Space	40 m <sup>2</sup>	7 m <sup>2</sup>	→ Save Space
Coatings	Solvent use	Non-solvent	→ Low Pollution

Table 1: Characteristic comparison of conventional drying method and EB method

In the case of the electron beam curing method, drying(hardening) completes in very short time. It is because the energy of the electron beam is very high. Therefore excelling in productivity makes the defective rate of the product can be restrained low. The base material does not receive the influence by heat in the electron beam curing method. Therefore doing can spend to heat freely even a weak base material even the product handling immediately after production is easy. There is the possibility that even the production cost can reduce because the energy efficiency is high. It is advantageous in an environmental problem because it does not include solvent in the

coating color and the low pollution able to expect.

Coating layer which was hardened by the electron beam has three dimensional cross-linked structure. Therefore it is considerably more excellent than the coating layer of water-based system, solvent-based system that the characteristics such as water-proof and chemical-resistance and heat-resistance has been used in an existing general paper processing field. Also even the damage is hateful the accompaniment because the surface strength is high.

The coated and cured surface has higher smoothness than that of conventional heat dry system.

## 2-2 Variations of the electron beam irradiation method

There is the permeability to a substance as one of the characteristics of the electron beam. By using this characteristic we can do various irradiation methods.

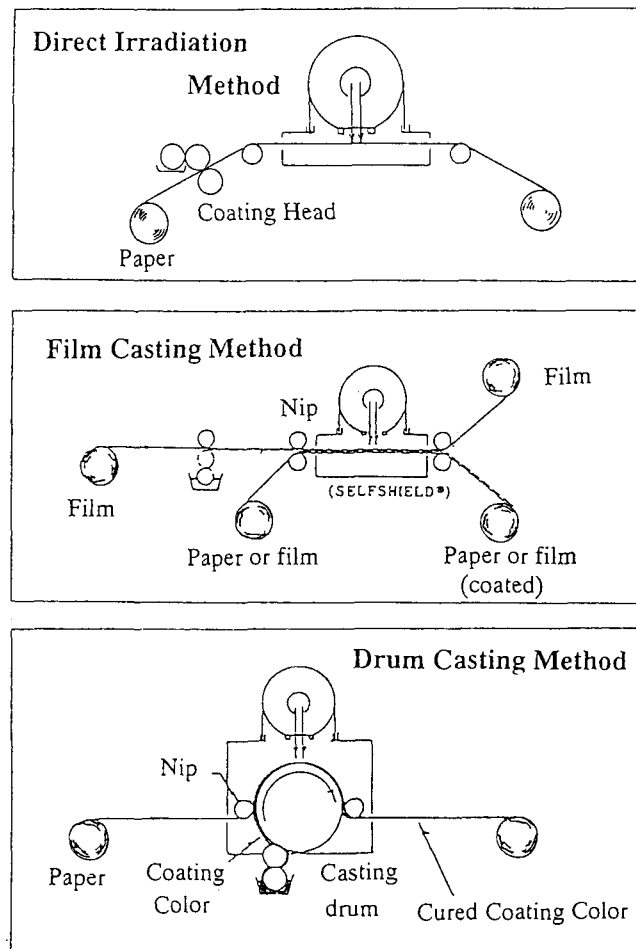


Figure 1: Variation of the electron beam irradiation method

It is very important thing to select the irradiation method that fits the purposes such as the function, productivity, cost of the product. Especially the electron beam curing method with casting drum (EB drum casting method) is the one that is skillfully using the characteristic of electron beam curing technology and an excellent characteristic is shown in the quality, economical efficiency and etc. of the products.

### EB drum casting method

In the EB drum casting method, the EB resin that was applied to the base paper is hardened in the condition which is contacting with the casting drum. The electron beam is irradiated through the base paper from the back side of the paper. The surface smoothness of the cast drum is transcribed on the surface of the product. If the surface of the cast drum is a mirror face, the surface of the product becomes a mirror face. If the surface of the cast drum is the one which has a pattern, the surface of the product becomes the pattern.

The EB drum cast method is the process that utilizes two characteristics of the electron beam permeability and the non-solvent coatings.

The surface of the product which was obtained with the EB drum casting method has more excellent smoothness in comparison with it of coated paper manufacturing process that has been carried out since before.

The surface form of the paper, that was obtained with conventional heat drying cast coated law and also extrusion laminating method and EB drum casting method was compared with the 3-dimensions smoothness tester chart. The result is shown in Figure 2.

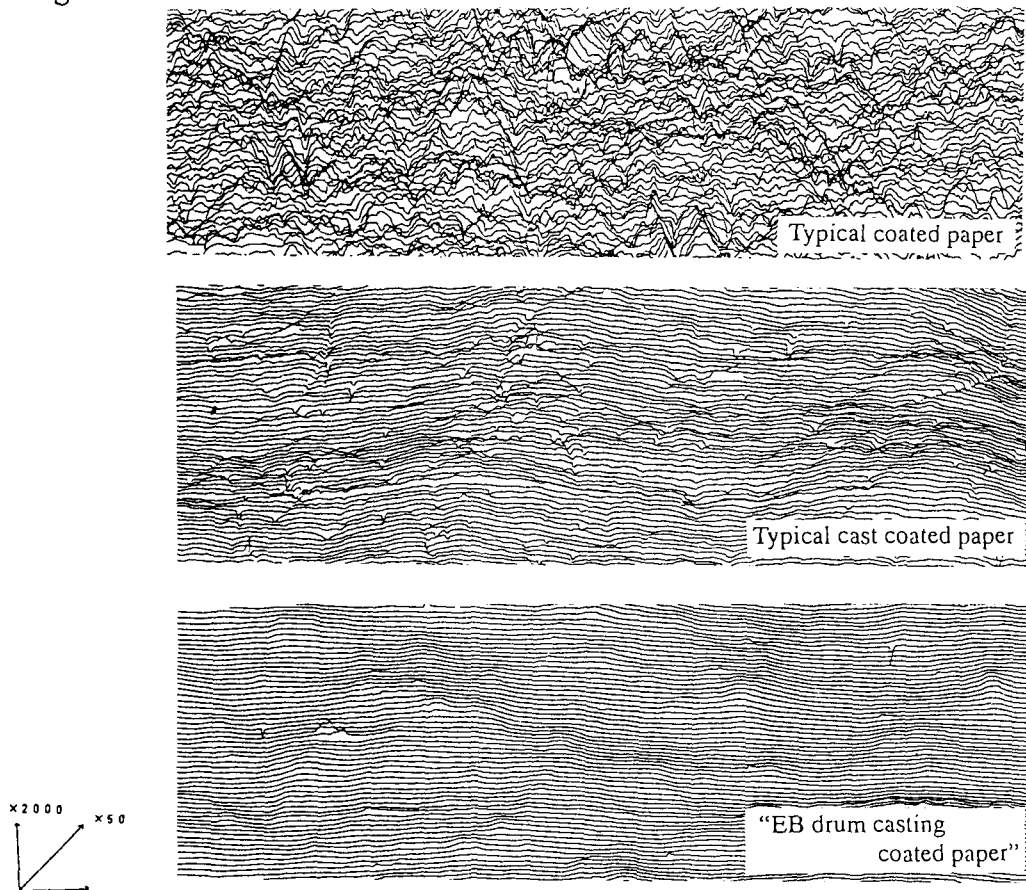


Figure 2: Three dimensions surface smoothness tester chart

### 3. THE CONSIDERATION POINT OF EB PROSECCING TO PAPER

There are several items to pay attention, in the case that it tries to apply electron beam curing technology to paper processing.

### 3-1 The deterioration of paper strength

The cellulose fiber that is the material of paper is deteriorated by the irradiation of the electron beam. As a result the mechanical strength of paper falls off. The deterioration degree is shown in the figure3 at the folding endurance of coated paper by electron beam irradiation as the example.

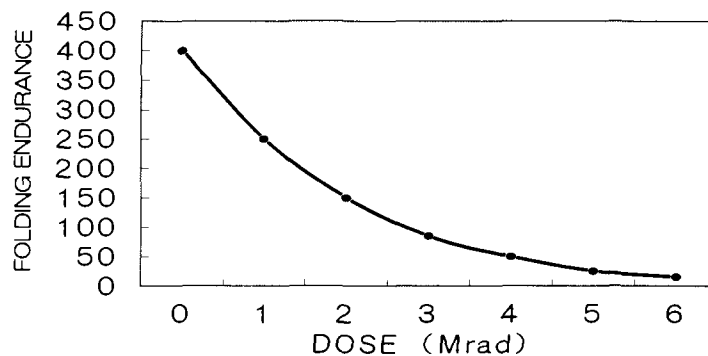


Figure 3: The deterioration degree at the time of resistance

The degree of the strength decline of the paper by electron beam irradiation was influenced by such things as the moisture and kind of paper. However, that the strength of the paper falls off is unavoidable. It is necessary to control electron beam irradiation strength as low as possible in order to restrain the strength decline of paper. Therefore, the electron beam curable resin needs to be high reaction type.

Even the accelerating voltage of the irradiation electron beam is an important point. In the drum casting method, the electron beam irradiation to the base paper is inevitable, because the irradiation of the electron beam is carried out from the back of the base paper. Therefore the accelerating voltage must be set up to the optimal size corresponding to the thickness of the base material, as the electron beam is irradiated to the EB resin application layer effectively.

### 3-2 Barrier property of paper

EB coating color penetrates into base paper layer using the usual paper without barrier. In this case, fine coated surface is not obtained by penetration. Therefore a proper barrier layer is necessary to the base paper. We can use the same material of barrier layer as it for general solvent system coating color. In this case, we must pay attention to the decline of the adhesive strength between the electron beam hardening resin layer and barrier layer. We can adopt to make paper of high size degree, or to make paper with another coated layer or laminated layer.

### 3-3 Adding the special function of EB coated paper.

EB curable coating color should be designed to get the following characteristics. The layer of cured resin have water-proof, chemical-resistance, scratch-resistance, flexibility, etc.

The EB resin can be cured with low dose, to prevent the decline of paper strength. The coating color viscosity is controlled in the proper range to get the smooth operation.

#### 4. VARIOUS KINDS OF PRODUCT THAT WE DEVELOPED

We made much effort in developing the high smooth, high gloss, and highly functional surface products. Our main research was to combine the coating resin and other additives, although we did examination regarding a necessary EB irradiation method to obtain the quality. Figure 4 shows the concept Figure of 1 pass 2 coating layers by EB drum casting method that our Oji developed.

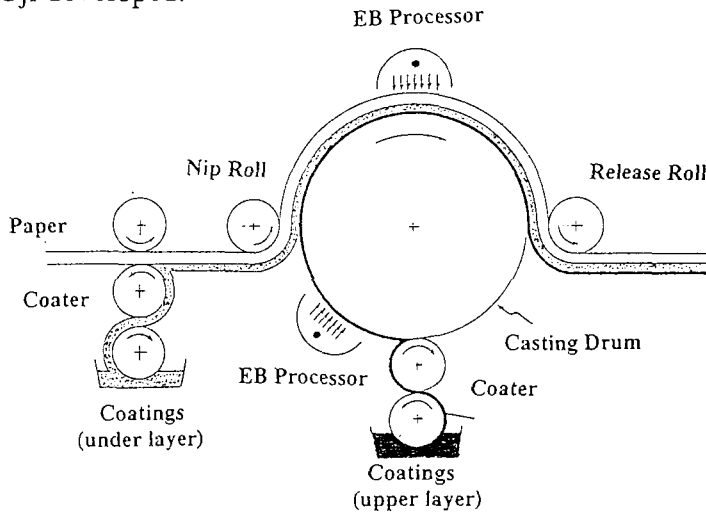


Figure 4: 1 pass 2 layer by EB drum casting method

By combining proper 2 coating heads and 2 EB irradiation devices that were arranged to 1 cast drum it became possible to develop the products that have an excellent function.

Up to now, we have developed the following products by utilizing this equipment.

(Available products for customers)

The ultra high gloss off-set printing paper for a poster, calendar, picture postcard

"Super Mirror PN"

The ultra high gloss printing paper for a commemoration album

"Super Mirror AL"

Paper base white board form

"Super Mirror WB"

(Special order products and new products under developing)

The process peeling paper for synthesis leather

High-grade photographic paper

Metalized base paper

Metallic paper

#### 5. POSTSCRIPT

By using applying electron beam curing technology we have developed various kind of new product.

Before the start of study, the electron beam curing technology was the unknown field for us. Therefore we couldn't help proceeding with much try and error. However, we could reach some succeeding point. We would like to develop deeper here after.