

Development of Cost-Effective and High-Property Mask in Flatron

Jong Mok Song, Byoung Nam Kim, Nam Je Koh, *Member*, Hyun Tae Chun and Ki Bum Park

Abstract

We developed the tension mask of which thickness increased from 25 um to 50 um to reduce the mask cost and improve the vibration property. First of all, the limitation by which rail structure can support is calculated and the optimal thickness of mask is determined. To prevent the reduction of brightness and brightness uniformity, the dimensions of mask was reassigned. As a result, the increase of mask thickness brought about a reduction in cost and improvement of howling property which had been a weak point of flat CRTs.

Keywords : CRT flatron, mask, tension

1. Introduction

Recently, a customer's interest and demand in the Flat cathode ray tube(CRT) has increased rapidly and the importance of flat CRT in market is growing continuously. So, the tendency of flattening CRT spreads broadly and most of CRT makers start to introduce new flat models or launch into new flat tube research. Thus, lowering the cost of flat CRT will be the most important factor for surviving in the market[1].

Because the Flatron mask is much thinner than the conventional or Sony-type mask, the difficulty in handling a mask caused some problems in the manufacturing of CRT has raised the mask price. Therefore, the price of Flatron mask which uses AK steel is expensive than that of conventional mask, which uses the inval. In addition, the thin mask shows a weakness in the outer dynamic impact. To prevent the vibration, three damping wires were used. So, it is the increase of mask thickness whuch is the effective solution for handling the vibration problem. But in the Flatron structure that the panel the rail is combined with rail by using frit glass and the rail support the mask tension, the force applied to frit by mask tension also increases simultaneously with increasing thickness of mask. This restricts the increase of mask thickness. Even if possible, it in turn decreases the brightness and brightness uniformity(B/U) at CRT.

In this study, we tried to determine the maximum mask thickness at which the rail can endure the tension force. Then, we decided the thickness of mask taking into consideration the mask material property, etching type(one-step or two step), mask productivity, transmission ratio and so forth. Finally, we developed the mask design process which helps improve the brightness and B/U decrease without any problem in the stretching process and the best way that can reduce the vibration of mask in Flat CRT by controlling a condition of damping wire.

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Jeong Mok Song, Byoung Nam Kim, Nam Je Koh, Hyun Tae Chun and Ki Bum Park are with the LG Electronics Inc., Display Device Research Laboratory, 184, Kongdan 1-dong, Kumi-city, Kyoun Buk 730-030, Korea. **E-mail** : oistrakh@leg.com **Tel** : +54 460-3287 **Fax** : +54 461-3901

2. Development of 50 um Mask

2.1 Strength between panel and rail

We took a test to decide the maximum thickness of mask in which the rail can endure. Fig.1 shows the schematic test equipment. To estimate the maximum mask force, we increased the applied tension force, step by step, until the frit glass broke away from the panel and gave this force to the FEM analysis of mask as a Natural Boundary condition. Then, we estimated the frit stress at different mask thickness respectively(25, 35, 50, 70, 80, 100um).

Fig. 2 shows the stress of frit-glass for different mask thicknesses and the critical stress for frit glass which is considered to be a the factor of safety. As a result, we concluded that the rail structure can bear the mask tension force until the mask thickness becomes 80 um.

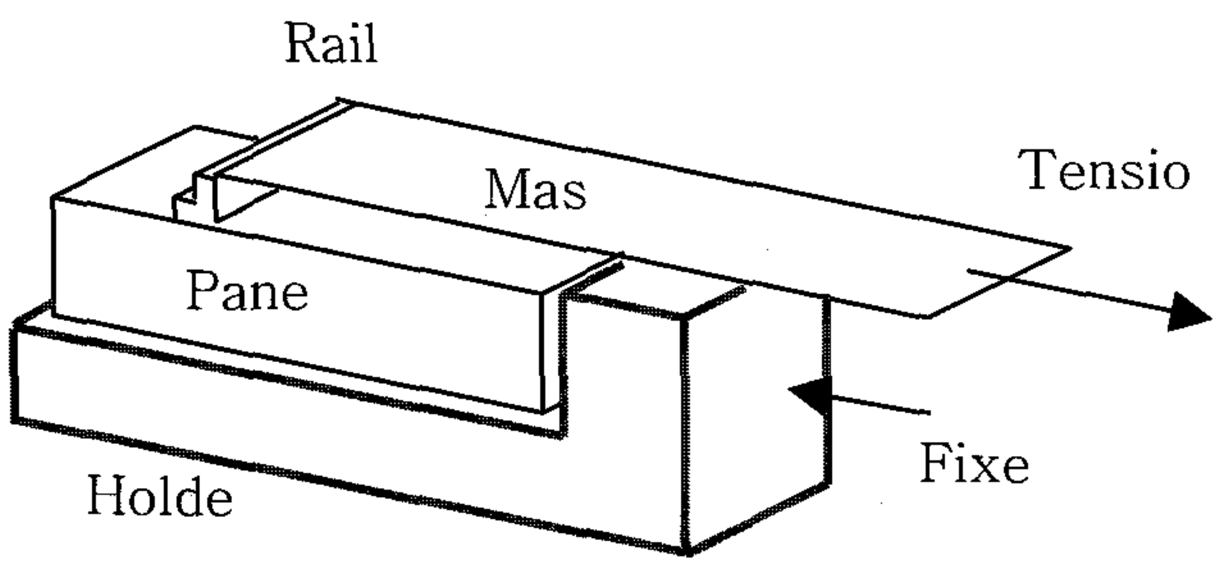

Fig. 1. The test equipment for firt strength.

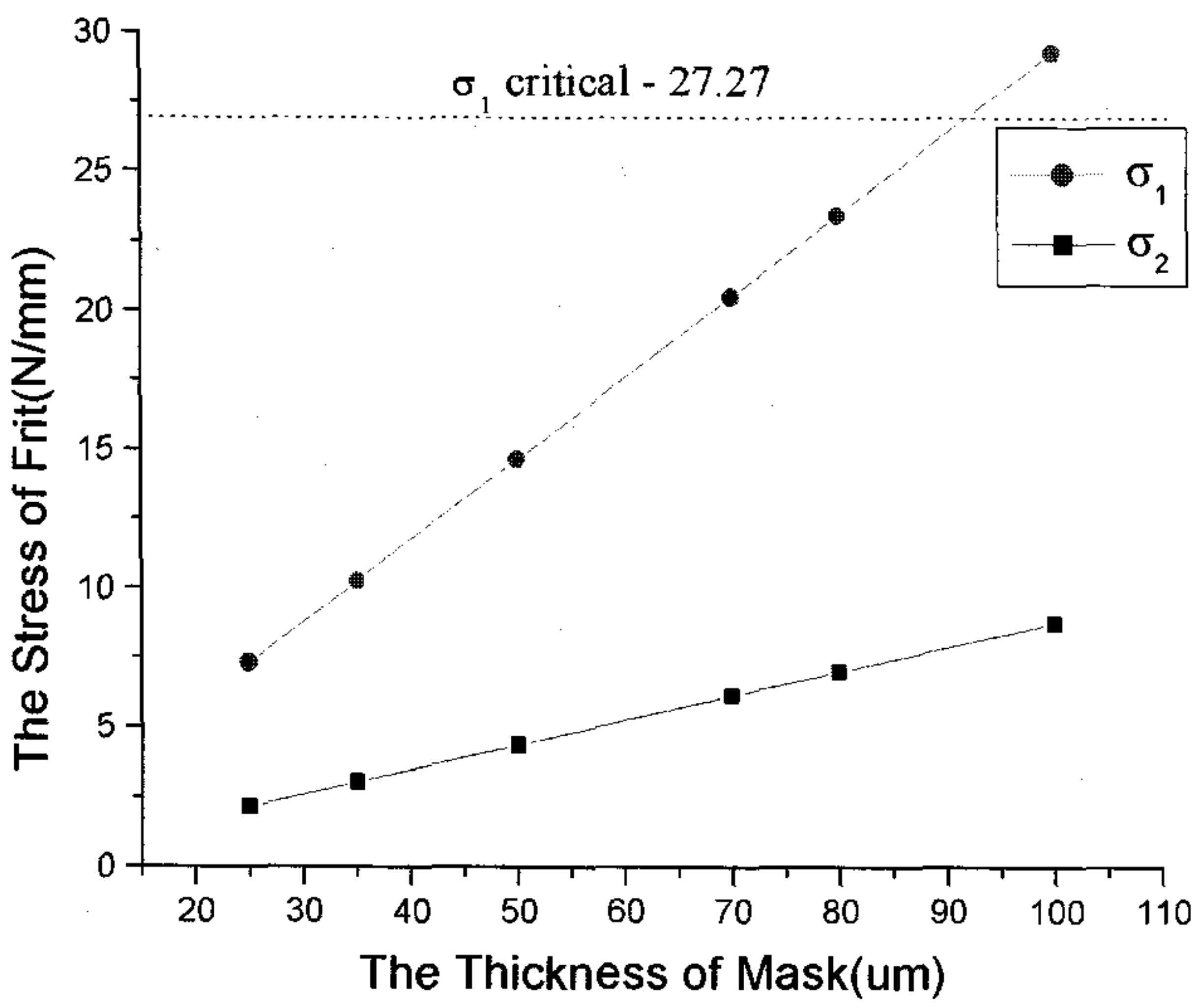

Fig. 2. Comparison of the principal stress of frit.

2.2 Material property of mask

The thickness variation changes the important property of mask just like a tensile strength(TS), elongation ratio and tensile creep. That is to say, before we change the thickness, it is essential to check the principal property of the material. Especially, The flat tension mask is needed in order to have a high tensile strength after annealing process and the elongation under 1 %.

The specimen of which thickness is, respectively, 25 um, 50 um and 80 um takes the annealing treatment at four different temperatures and the tensile test is taken at following conditions. - applied load : 10000N, speed: 1 m/min., and Gage length: 50 mm. The tensile creep test is based on the method of which the JIS-2271 is specified.

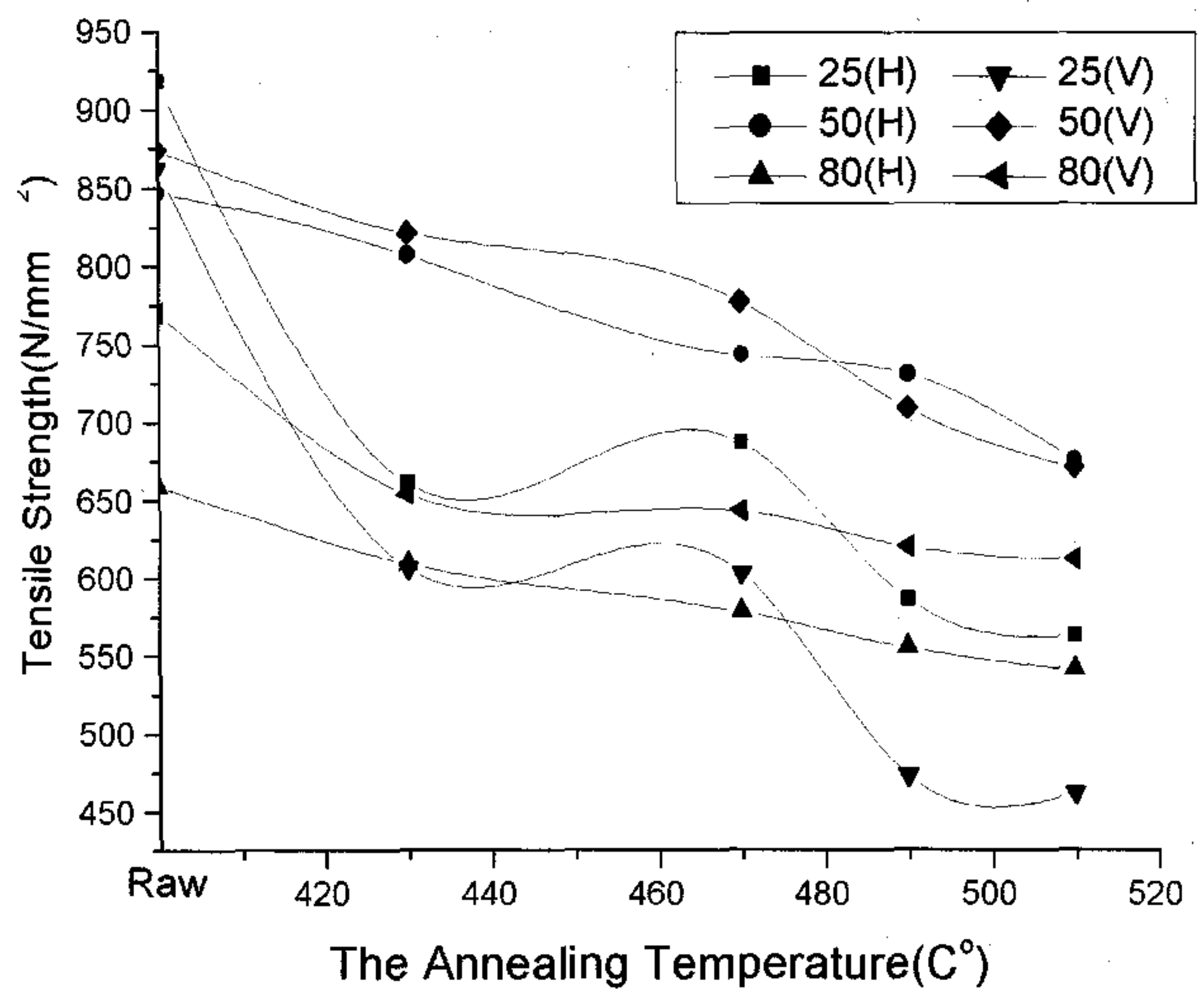

Fig. 3. The tensile strength of the mask material.

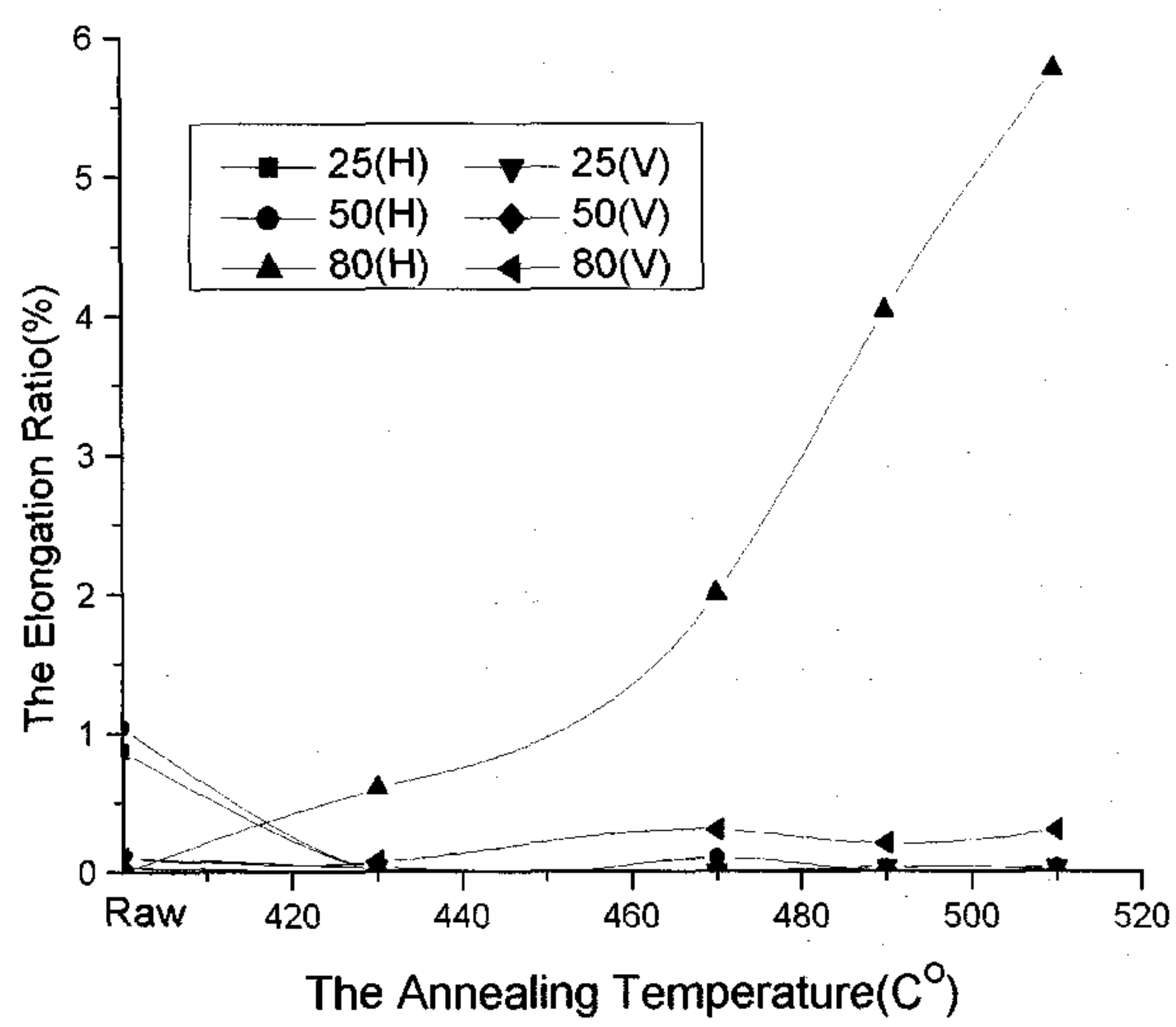

Fig. 4. The elongation ratio of the mask material.

Fig. 3 shows the tensile strength of mask material along the temperature of annealing treatment. The 'H' means the horizontal direction for the rolling of raw material and the 'V' means the vertical direction. In Fig. 3, the tensile strength tends to decrease according to the increase of the mask thickness. Before the annealing treatment, the 25 um mask shows the highest tensile strength. But the TS of 25 um mask cut down after the annealing treatment. At both the horizontal and vertical direction, the 50 um mask show the highest strength and cut the strength down slowly in comparison with others.

Below 510 ℃ treatment, the 25 um and 50 um material show the elongation ratio under 1 % which is appropriate to the tension mask in Fig. 4. At the horizontal direction, the elongation ratio of the 80 um mask goes up to 6 % in proportion to the temperature increase.

2.3 Mask design

In considering the economic advantage like the reduction of the mask cost and the ease of handling, It is more preferable to increase mask thickness. On the other hand, this brings about the expansion of bridge wide(Br) and reduces the beam translation ratio. Consequently, it is preferably be considered to maintain the brightness and B/U at the same level with 25 um mask.

Within 50mm from the center of screen, the incidence angle of beam is not so large that the principal issue is the determinant of bridge width(Br). The decrease in Br can improve the brightness near the center of the screen. But the size of Br is limited by the stretching process at the slot-aperture mask. If the Br is under 30 um at the 50um mask, the mask will not be able to endure the tension force during the stretching.

In order to take the B/U up to 85 % at the corner of the screen, the design of vertical taper(Uo) and gun-side tie bar width(Bb) is very important. Even though the Br is the same value, the reduction of Bb can increase the Brightness and B/U. The slit corner radius(R) which has a great effect on the translation ratio tend to enlarge proportionally the thickness. Fig. 5 shows the bad shape of the hole. The slit corner R is almost equal to half the slot width. To reduce the slit corner R and Bb, the slot width was expanded to about 1-2 um[3].

Based on the test, the optimal size of Bb and Uo was, respectively, 33-35 um and 27-30 um. Table 1 shows the mask dimension for the 25 um and 50 um mask.

TABLE 1. The dimension of 25 um and 50 um mask.

Thickness	25 μm		50μm	
	Center	Corner	Center	Corner
Br	27	27	38	43
Bb	27	27	33	36
Bf	10	10	15	15
Sw	55	59	57	61

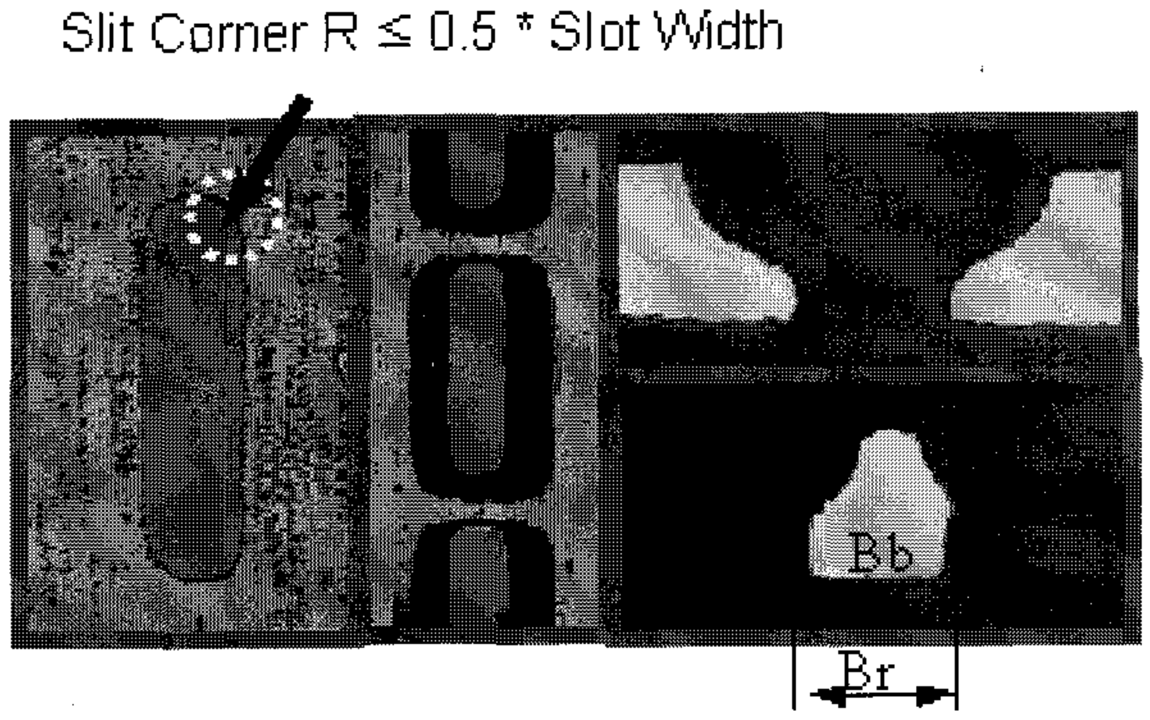

Fig. 5. The shape of 50um mask hole.

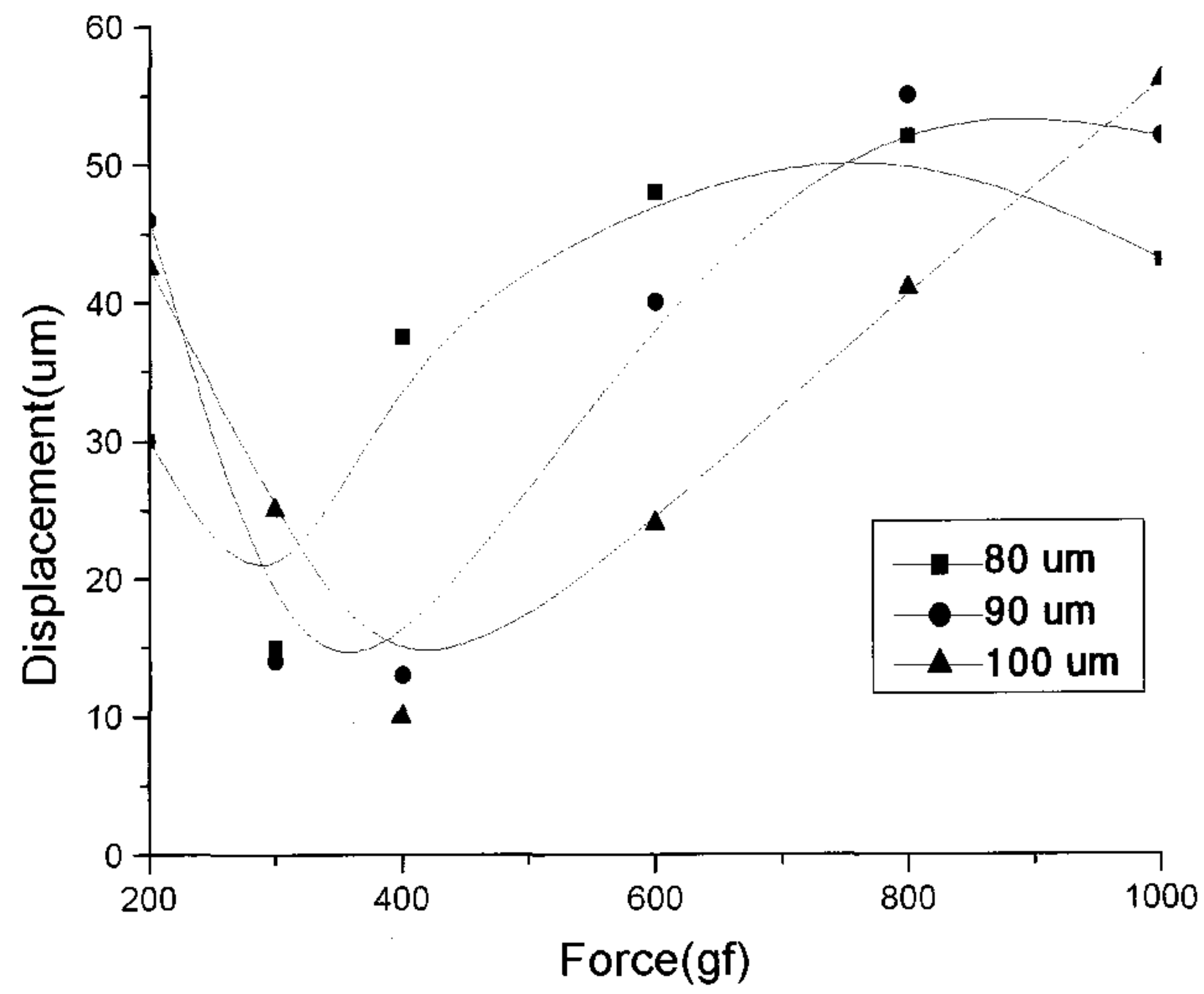

Fig. 6. The displacement of mask after the impact applied (1 sec, x=0 cm).

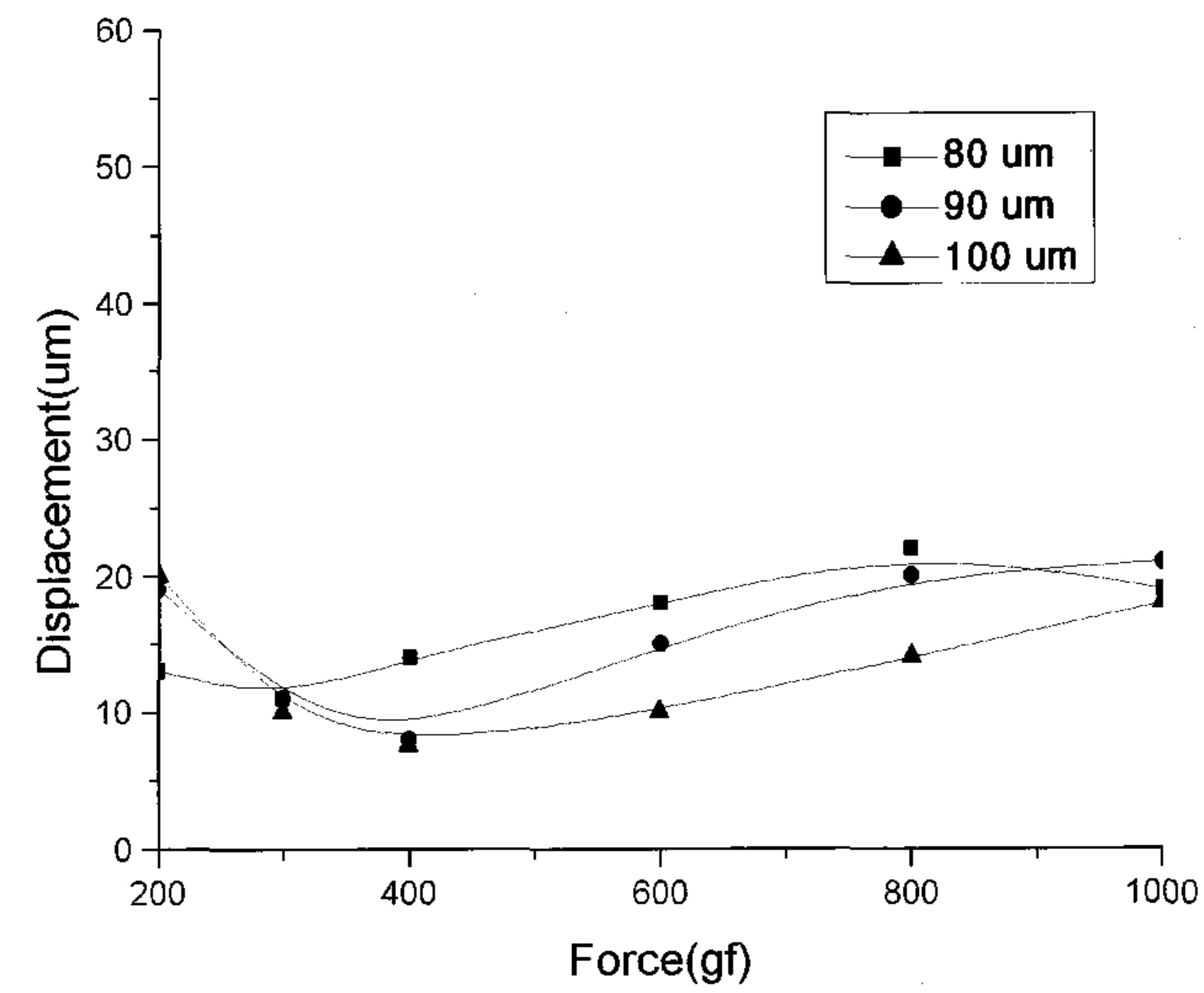

Fig. 7. The displacement of mask after the impact applied (1 sec, x=127 cm)

2.4 Mask vibration control

Even though the 50 um mask improves the vibration characteristics, It has to be considered in advance to prevent the resonance between the mask and the damping wire. For this purpose, we did the modal analysis for both the mask and the wire including the thermal effect. Then, we did the transient analysis in regards to the different condition- the wire diameter (80 um,90 um,100 um), the tension force applied to wire (200-1000 gf)and the number of damping wire[2].

Fig. 6 and 7 show the displacement of mask at the following conditions-1 wire at center, x=0 and x=127 cm and after 1sec. The displacement at 300 gf and 100 um is about 20 um. This value is very low in comparison with the 150 um at the 25 um mask. The optimal tension force range is between 300 gf-600 gf for the every wire diameter. Because of both the economic reason and the productivity, we select the wire diameter as 80 um. Applying this condition to the Flatron, we reduce the number of damping wire from 3 to 1 and the mask vibration time under the 10 sec.

3. Conclusion

We presented the design process for increasing the thickness of the flat tension mask and the principal concept for compensating the brightness and B/U. In addition, a useful way for reducing the vibration of mask is given.

With this research, we could reduce the cost of mask dramatically and accomplish better property of tubes. Finally, this research can be seen to be the fundamental step in developing the mask for the high resolution CRT.

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