



White Paper

Advantages of Anti Reflection (AR) treatment

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1. INTRODUCTION

Anti Glare (AG) treatment is generally used for LCD monitors to reduce reflected images. But AG treatment has a disadvantage that it increases brightness of black and worsen sharpness. To deal with the issue, EIZO releases monitors with Anti Reflection (AR) treatment, which overcomes the disadvantage of AG treatment. AR treatment achieves displaying high quality medical images by anti-reflective characteristics, sharpness and contrast in bright environment better than AG treatment.

This white paper shows advantages of AR treatment.



2. Anti Glare (AG) treatment

2-1. Outline

As Figure 1 shows, AG treatment reduces reflected images with micro convexities which reflects ambient light (or incident light in Figure 1) and makes reflected image vague, leading to reducing reflected images. Since AG treatment can reduce reflected images even in an environment where there are many lights, most LCD monitors use AG treatment.

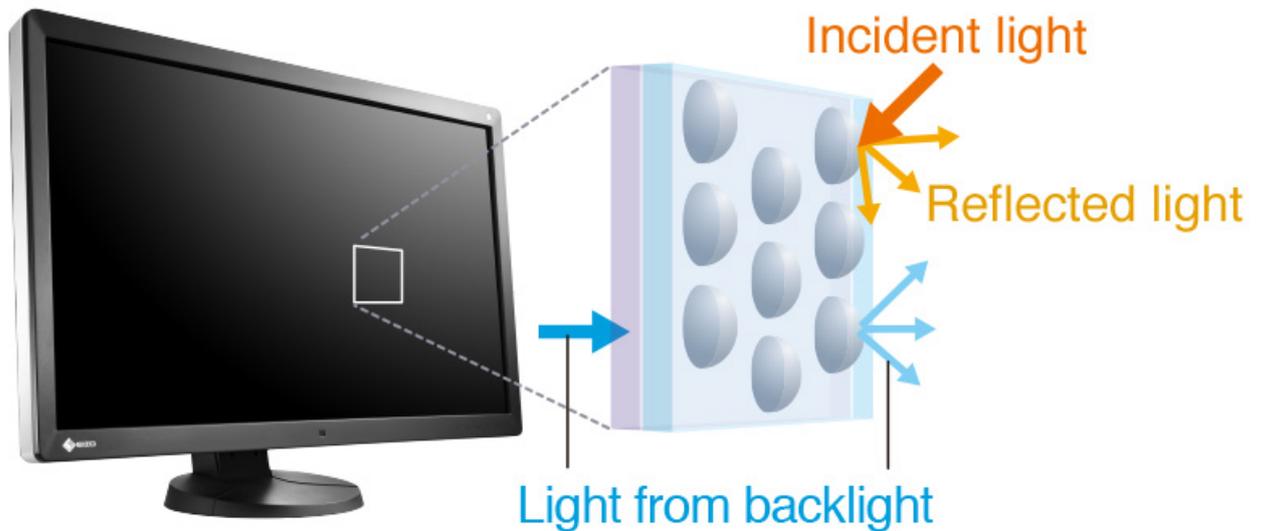


Figure 1: AG treatment

2-2. Problem

Reflecting incident light diffusely makes reflected light a bit white, which leads to increase brightness of black and it worsens contrast ratio.

As Figure 1 shows, AG treatment diffuses the backlight. It worsens sharpness of images. In addition, interference of reflected components would cause sparkling.

3. Anti Reflection (AR) treatment

3-1. Outline

AR treatment reduces reflected images by light interference (phase reversal by thin layer). Whereas AG treatment just reflects incident light diffusely, AR treatment reduces reflected light. In addition, since AG treatment does not have any convexities, light from backlight goes through without reflection, so AR treatment can show sharper images than AG treatment.

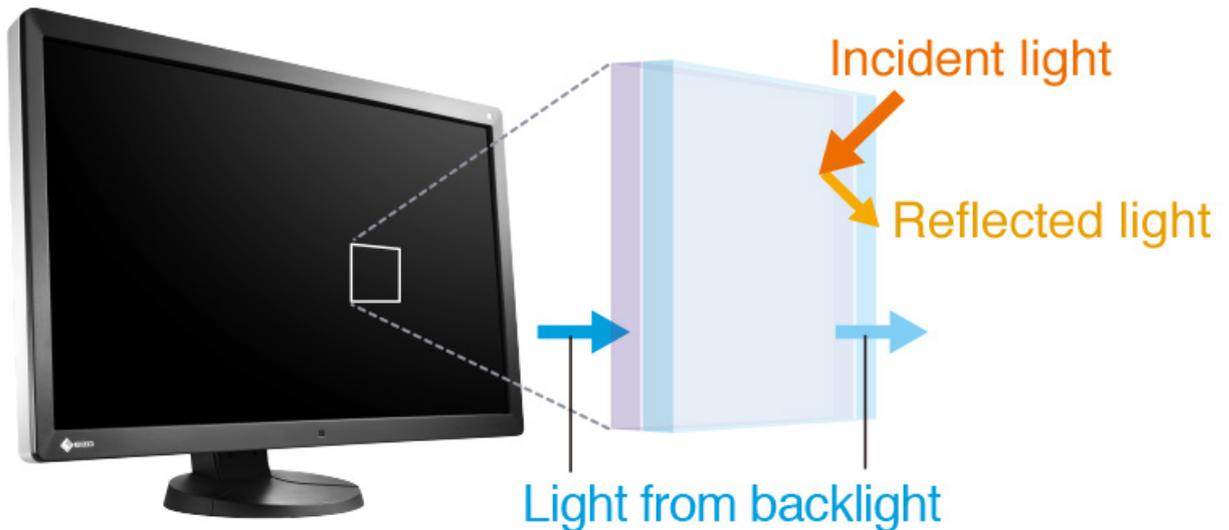


Figure 2: AR treatment

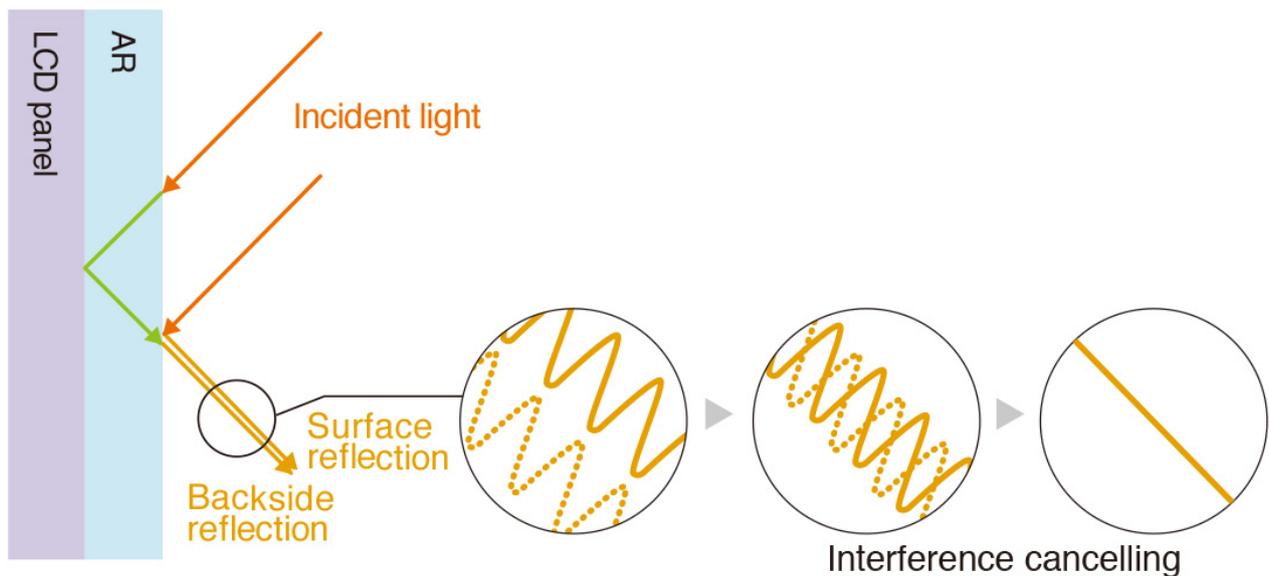


Figure 3: Phase inversion by a thin layer of AR treatment

3-2. Features of AR treatment

This chapter explains advantages of EIZO AR treatment against AG treatment and conventional AR treatment with data and pictures.

[Spectral reflectance characteristics]

Since each wavelength of light has different reflectance (spectral reflectance characteristics), we measured reflectance of each wavelength with both AR treatment and AG treatment. There are two types of reflection; one is specular reflection (reflected light with the angle same as incident light), and another is diffuse reflection (reflected light not depending on the angle of incident light), so we measured both separately. Figure 4 shows that AR treatment has lower reflectance with both specular reflection and diffuse reflection, which means that AR treatment is superior to AG treatment.

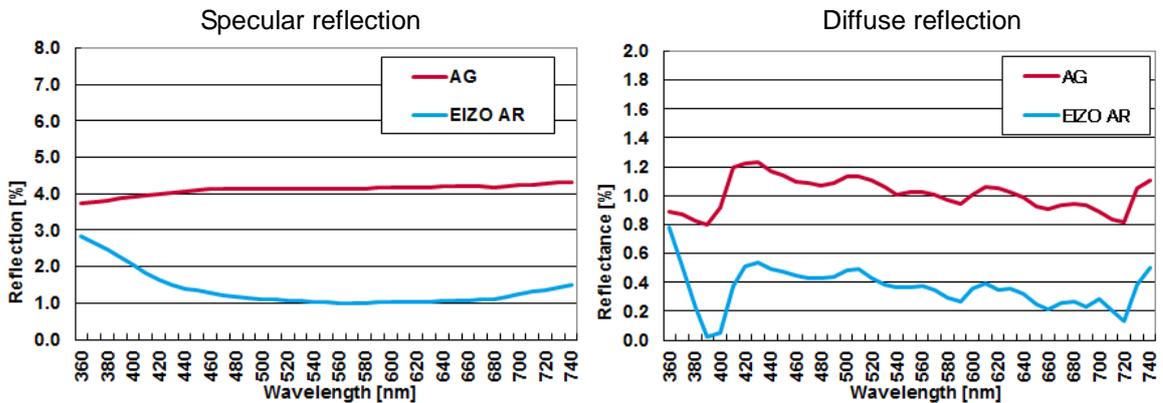


Figure 4: Spectral reflectance characteristics (compared with AG treatment)

And we found that EIZO AR treatment has flatter reflectance than conventional AR treatment. As Figure 5 shows, conventional AR treatment has higher reflectance at specific wavelengths and reflected images are purplish (because the shorter wavelength region covers blue and the longer wavelength region covers red.) Compared with conventional AR treatment, reflected images of EIZO AR treatment are much less obtrusive thanks to its flatter reflectance which does not give color to reflected images.

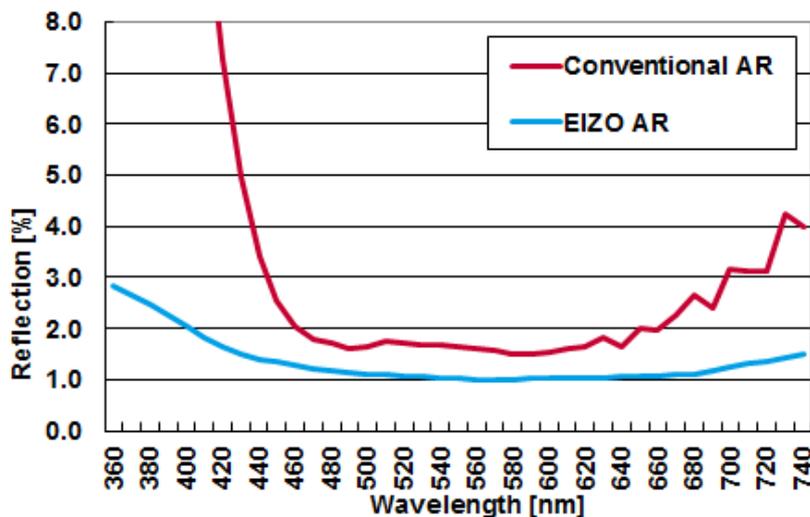
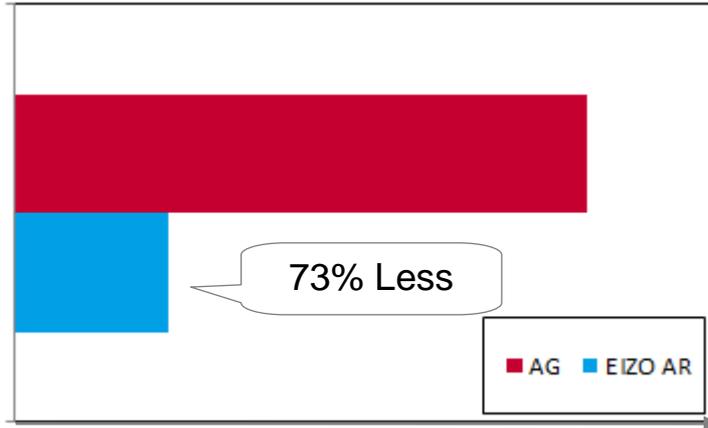


Figure 5: Spectral reflectance characteristics (compared with Conventional AR treatment)

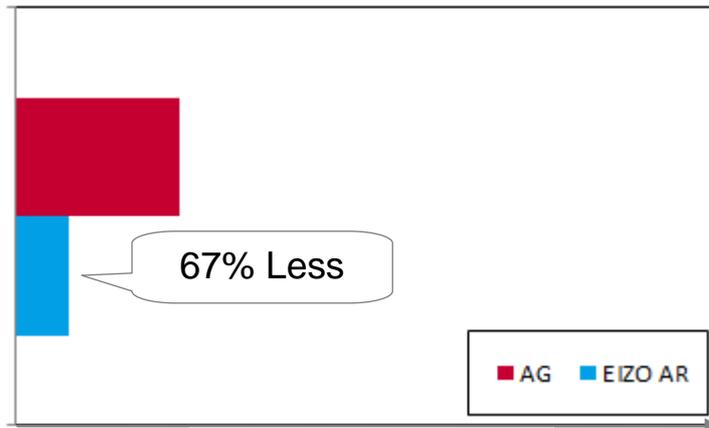
[Luminous reflectance]

We measured luminous reflectance, a index of reflectance which considers luminous sensitivity of eyes and found that AR treatment is superior to AG treatment. As Figure 6 and Figure 7 show, AR treatment reduces specular reflection by 73% and diffuse reflection by 67% compared with AG treatment. It means that a user feels reflected luminance of AR treatment less noticeable than AG treatment.



Reflectance

Figure 6: Luminous reflectance (specular reflection)



Reflectance

Figure 7: Luminous reflection (diffuse reflection)

[Contrast in bright environment]

We measured contrast in bright environment. Specs of contrast is generally measured in dark environments in which there is no ambient light but contrast ratio and grayscale characteristics are affected by ambient light. This section shows you how reflected components affect image quality of monitors.

Contrast Ratio

Figure 8 shows contrast ratio with each illuminance which considers reflected luminance. The monitor was calibrated to maximum brightness of 500 cd/m² and minimum brightness of 0.7 cd/m².

Whereas contrast ratio of AG treatment worsens sharply with ambient illuminance increasing, AR treatment can keep its contrast ratio higher. Therefore, AR treatment realizes high image quality with higher contrast ratio in bright environments. For example, AAPM TG18 Online Report No.03 requires contrast ratio of 250:1 or more and Figure 8 shows that AR treatment is more effective to meet it in bright environments.

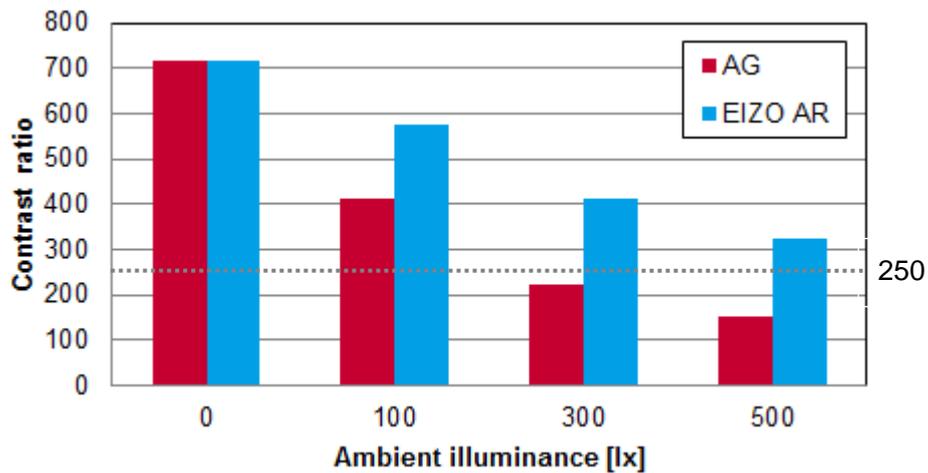


Figure 8: Contrast ratio with each illuminance

Grayscale characteristics

Figure 9 shows grayscale characteristics with each illuminance which considers reflected luminance. The monitor was calibrated to GSDF, grayscale characteristics generally used for medical monitors. We found that grayscale characteristics with AG treatment are affected by ambient light more than the ones with AR treatment. Darker images with AG treatment look more whitish than AR treatment.

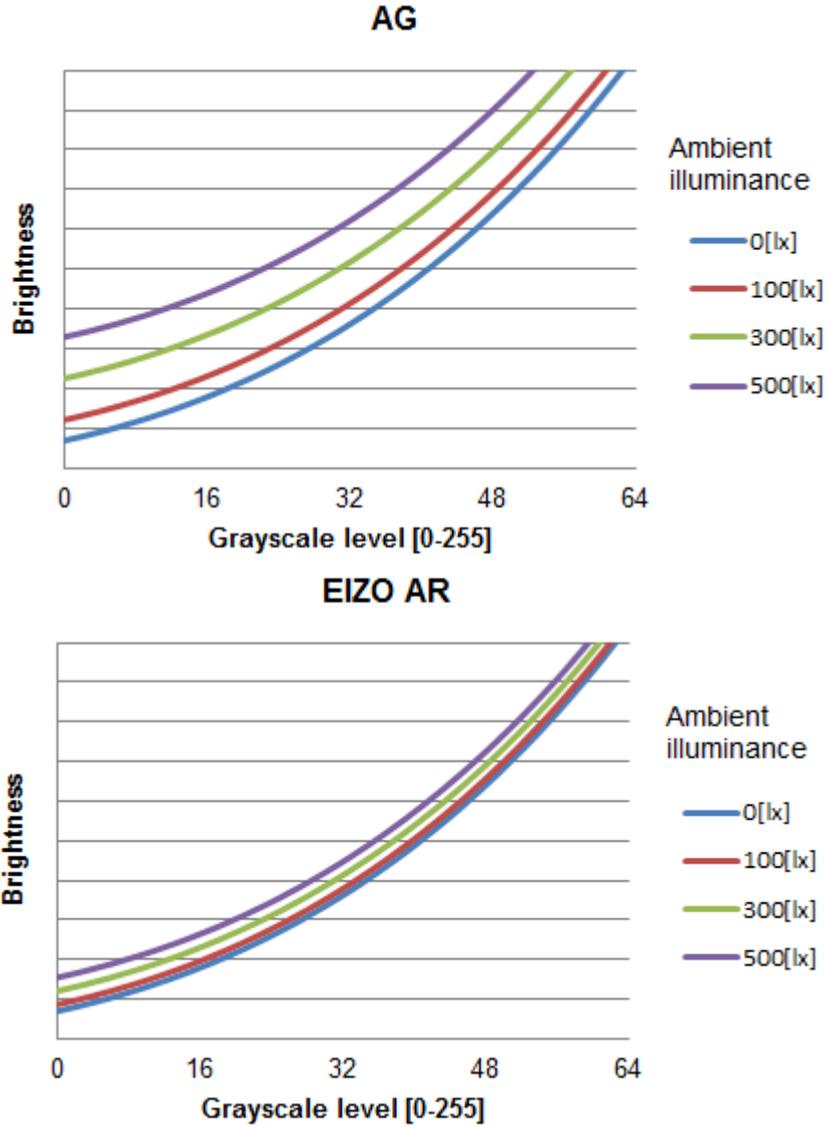


Figure 9: Grayscale characteristics with each illuminance

[Modulation Transfer Function (MTF)]

The last topic is sharpness. MTF is a index which represents how sharp displayed images are. Figure 10 is a graph of MTF; x-axis shows spatial frequency and y-axis shows MTF value. The nearer the MTF value is 1.0, the sharper the images are. As Figure 10 shows, MTF of AR treatment is superior to that of AG treatment. The sharpness of RX850 with AR treatment improves by approx. 11 % at spatial frequency of 2.9 cycles/mm compared with AG treatment. Therefore, AR treatment achieves sharper images than AG treatment.

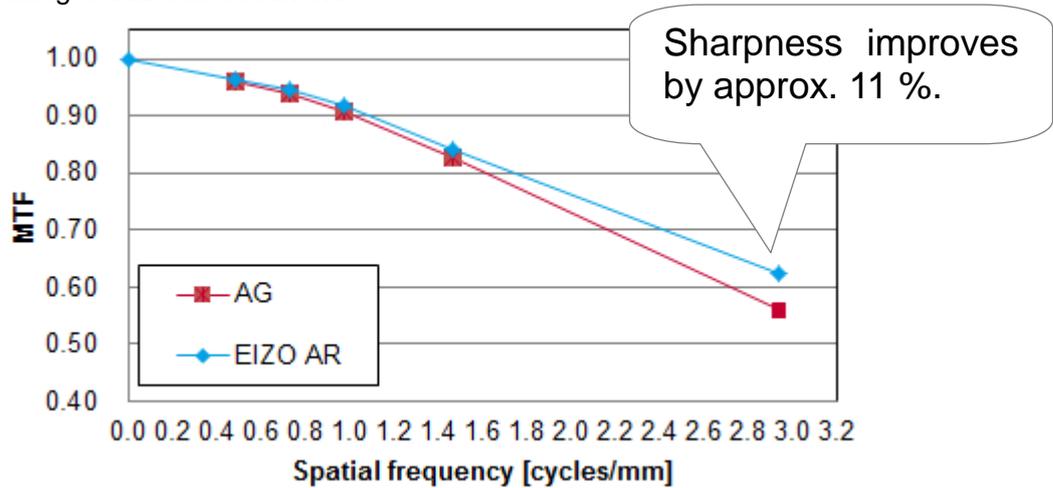
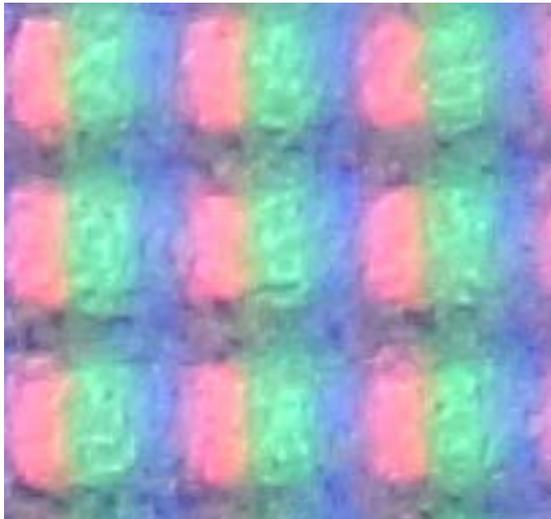
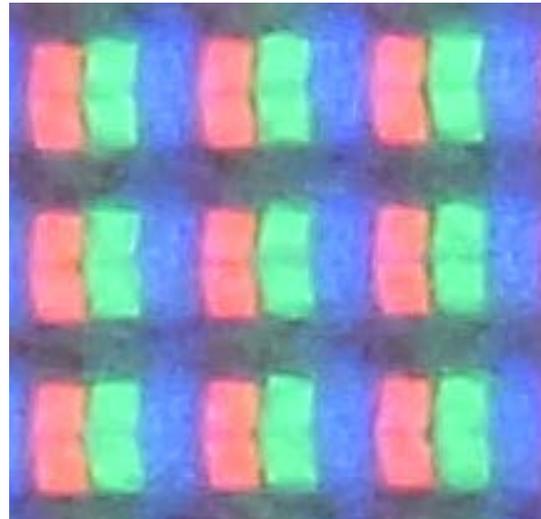


Figure 10: MTF of RX850

The pictures in Figure 11 are of pixels of an LCD panel. The picture of AR treatment is more vivid than AG treatment, which leads to good sharpness.



AG treatment

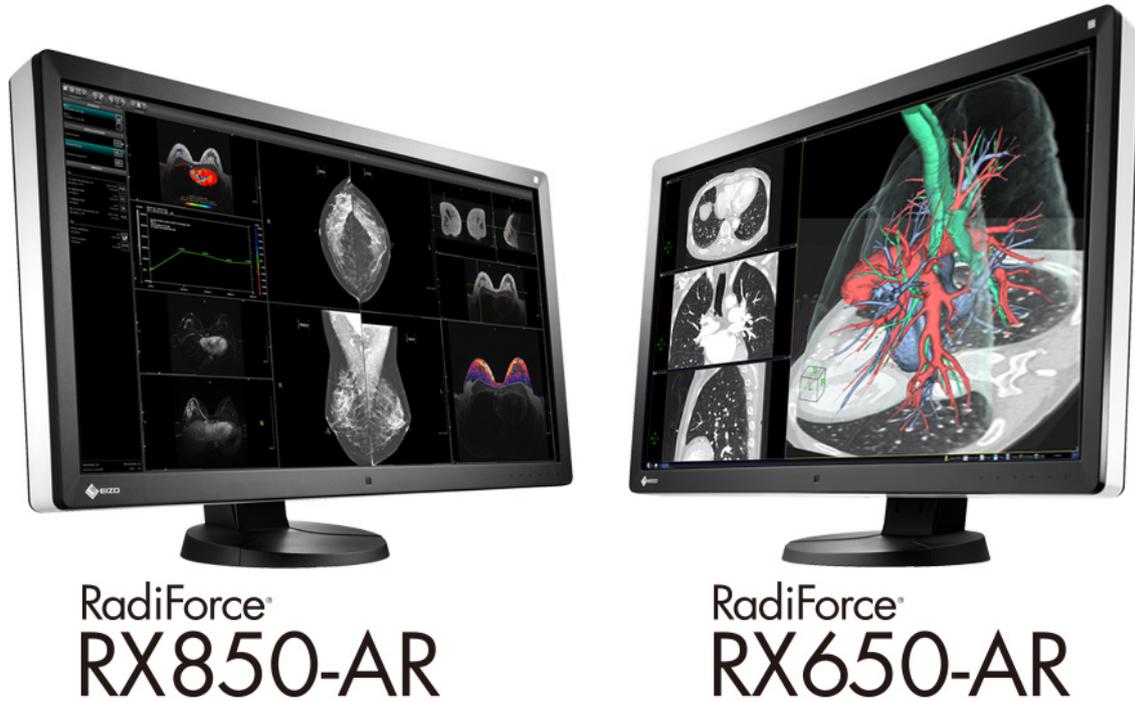


AR treatment

Figure 11: Pixels of a LCD panel

4. SUMMARY

EIZO AR treatment achieves excellent anti-reflection characteristics. Compared with conventional AR treatment, EIZO AR treatment makes reflected images on screen less noticeable and has better characteristics in bright environments. In addition, EIZO AR treatments can keep images sharper than AG treatment even in dark environments. Therefore, EIZO AR treatment provides high quality images in various environments.



Note) all figures are not based on the measurement result but simplified images.

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