High Resolution X-Ray Inspection Microscope equipped with a Field Emission Gun and its Application

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Until now, the spatial resolution of Projection X-ray Microscope Inspection Systems using thermal electron emitters such as those made of lanthanum hexa-boride (LaB_6) has been achieved to a level just better than 0.4μm[1]. Now, we have developed an X-ray Microscope Inspection System using a thermal field electron emitter coupled with a new type of electron condenser lens. This system is capable of 0.1μm spatial resolution.

Our currently achieved spatial resolution has been measured with a 2000 lines/mm, 0.2μm thick gold grid. Figure 1 shows an X-ray image of the gold (Au) grid taken with photographic film, using a 0.4μm thick Cr-target, at applied voltage 25kV, where we can clearly see Fresnel fringes. We estimated the resolution as half the width of the first maximum of the Fresnel fringes, as suggested by Cosslett and Nixon[2]. The width of the first maximum of the Fresnel fringe is 0.2μm which is expressed as $2d_F$ in the micrograph. By substituting b=50μm(the spacing between the target) and λ = 0.23nm(wavelength of Cr K_α-line) to the relation $d_F = (b\lambda)^{1/2}$, we have d_F = 0.107μm. So it is reasonable to infer that the Fresnel fringes are formed by Cr K_α-line.

Emulsion layers of photographic films were examined with the X-ray microscope before and after development and independent particles postulated to be AgBr and Ag were observed. Some other examples will be reported.

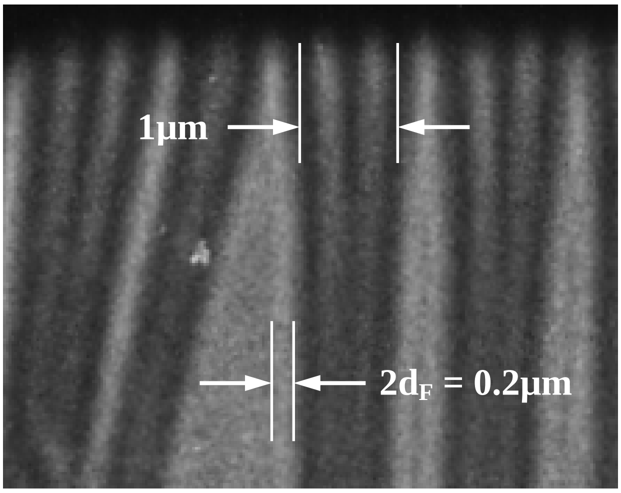

Fig.1 X-ray micrograph of gold transmission grating (2000 lines/mm) taken with photographic film, Cr target 0.4μm thick, 25kV. From the width of the first maximum of Fresnel fringes, spatial resolution of about 0.1μm is proved.

References

[1]M.Watanabe, H.Kai, K.Oohashi, K.Yada and B.Willis, New X-Ray Microscope Achieves 0.4-Micron Resolution. *Review of progress in quantitative nondestructive evaluation,* Vol. 21A, pp. 606-612. (2001). American Institute of Physics.

[2]V.E.Cosslett and W.C.Nixon, The X-Ray Shadow Microscope. *J. Appl. Phys.* **24**, 616-623 (1953).