A study of characteristics of a microcolumn based on CNT emitters

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An electron beam device has been used mainly for inspection or lithography process. Since the processes using electron beam devices take a long time especially in case of electron beam lithography, the multi-beam lithography using multiple microcolumns(multi-column) has been developed to solve a low throughput issue. [1,2] However, the multi-column has some drawbacks. A first drawback is that it is difficult to make the multi-column itself. Especially, the alignment process of a source lens and a tip requires sophisticated techniques. A second drawback is that electron beam characteristics of microcolumns constituting the multi-column are different from column by column.

In order to solve the alignment problem of the first drawback, we considered a two dimensional carbon nano tube (2D-CNT) electron emitter instead of the widely used tungsten field emitter tip.The area which the 2D-CNT emitter covers is larger than the extractor aperture area of the source lens. This design has an advantage. The advantage is that an alignment process of a source lens and the 2D-CNT emitter is much easier than the past.

Using the microcolumn adopting 2D-CNT emitter, we obtained both a normal SEM image and an overlapped SEM image, as shown in Figure 1(a) and (b), respectively.We performed a simulation study to investigate the origin of the overlapped SEM image on the assumption that multiple CNT emitters are activated simultaneously and contribute the overlapped image formation. In this simulation model, we assumed that two adjacent emitters are activated and the lateral distance between them is ~5 um. As shown in Figure 2 and 3, the focal point and the focused beam spot size from each emitter is different each other, which is the origin of the overlapped image shown in Fig. 1(b). In this paper, we will discuss the way of eliminating the overlapped image in a microcolumn with 2D-CNT emitter.

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[1] E. Kratschmer, H.S. Kim, M.G.R. Thomson, K.Y. Lee, S.A. Rishton, M.L. Yu, S. Zolgharnain, B.W. Hussey, T.H.P. Chang, J. Vac. Sci. Technol. B, 14 (1996), p. 3792

[2] T.H.P. Chang, M.G.R. Thomson, E. Kratschmer, H.S. Kim, M.L. Yu, K.Y. Lee, S.A. Rishton, B.W. Hussey, S. Zolgharnain, J. Vac. Sci. Technol. B, 14 (1996), p. 3774

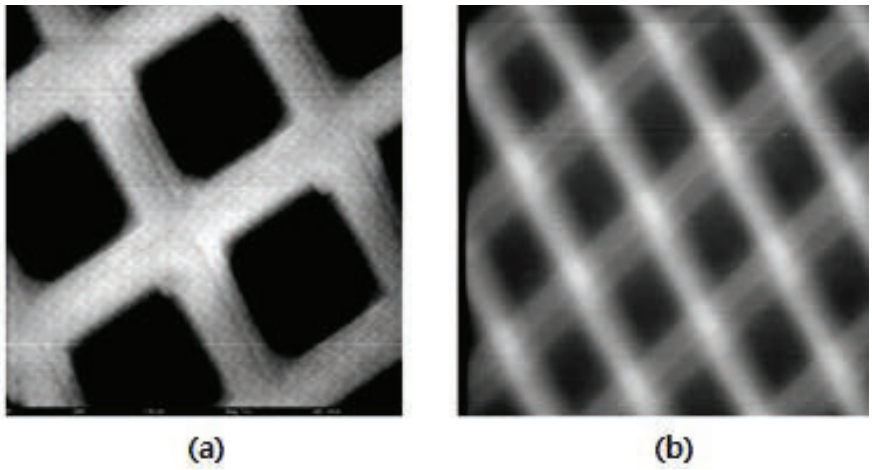

Figure 1: The SEM images of the copper grid*using the microcolumn adopting 2D-CNT tip:* (a) the normal SEM image, (b) the overlapped SEM image

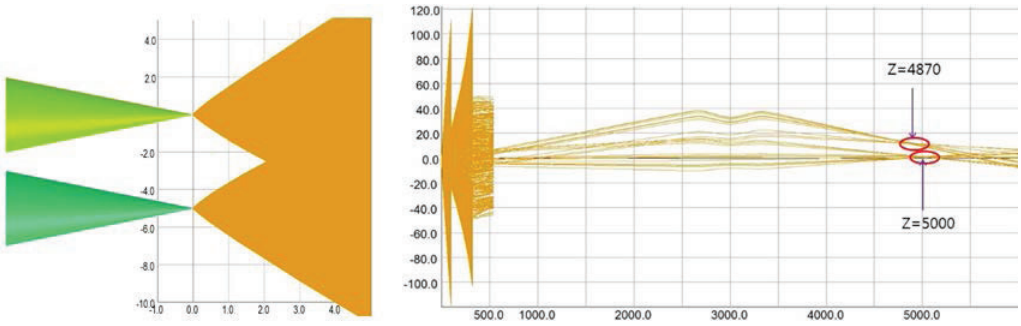

Figure 2: Simulation results of the electron beam trajectories emitted from two adjacent tips.

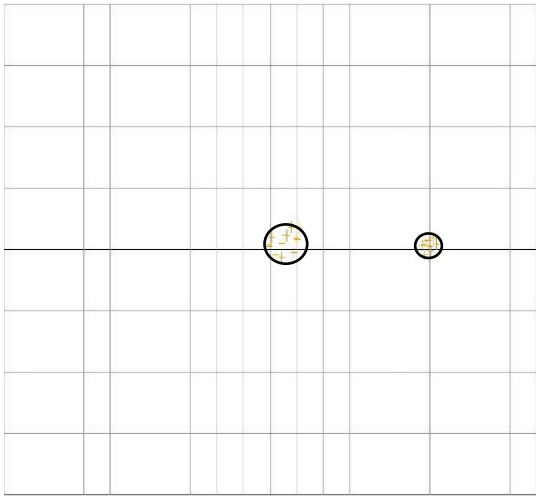

Figure 3: Simulation results of the electron beam spot sizes at the sample surface