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A Study of Beam Sensitive Materials Using High resolution, ULV Scanning Electron Microscopy

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Low voltage scanning electron microscopy has become common both for topmost surface imaging and reducing beam damage [1]. Lately, high resolution, ultra-low-voltage (ULV) imaging (less than 500 V) has been realized by beam retarding [2] and/or boosting [3] techniques. In this study, some beam sensitive materials are observed by the Hitachi S-4800, which employs a cold field emission source, snorkel type objective lens and a retarding function [4].

Figure 1 shows images of PTFE (polytetrafluoroethylene). Images were captured first at 50kX (high magnification) and then at a lower magnification- 20kX, at the same area in order to identify morphological changes between 100V and 500V. The 500V, 50kX image (Fig.1(a)) exhibits a different surface structure when compared to the surrounding area seen at 20kX (Fig.1(b)). On the other hand, with the100V landing voltage, the 50kX image (Fig.1(c)) has almost the same topographic information as the 20kX image (Fig.1(d)), even though EB dose at 50kX is 6 times more than that at 20kX. This shows that 100V imaging minimizes morphological change for this specimen, which may exhibit crystalline transformation between 50 to 60 degrees C.
Figure 2 shows images of ArF resist at 100V and 800V. ArF resist shrinks because of solvent evaporation due to chemical reaction or temperature rise by EB irradiation [5]. The 100V image (Fig.2(b)) can evaluate edge roughness more accurately than 800V (Fig.2(a)) with less shrinkage.
Additional studies are reported such as the combinations of coating or cryogenic techniques, and ULV imaging for a wider field of applications.

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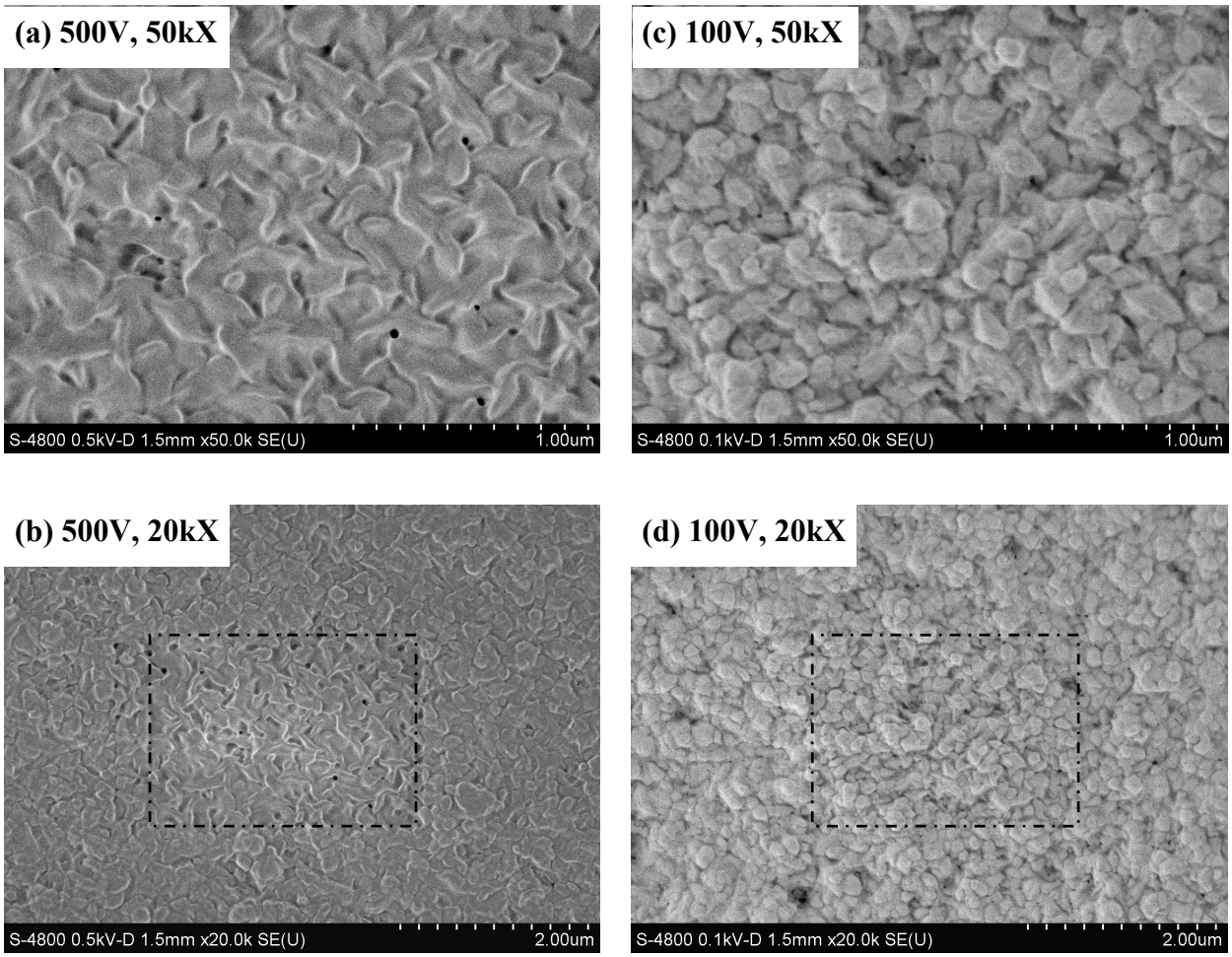

Figure 1 PTFE images

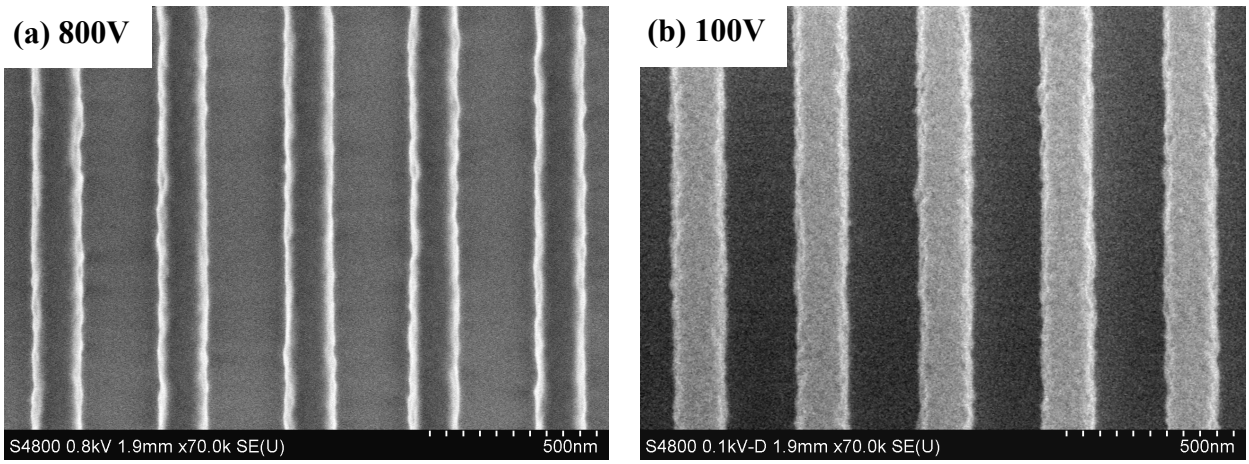

Figure 2 ArF resist images

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