

Supplementary Information

Figure S1. Bright field TEM images of acidic Nafion. **(a,b)** images collected at room temperature with 500 e/nm^2 at rate $500 \text{ e/nm}^2 \text{ s}$; **(a)** from initially undamaged sample; **(b)** after 10000 e/nm^2 ; **(c,d)** images collected at cryo-temperature with 300 e/nm^2 at rate $300 \text{ e/nm}^2 \text{ s}$; **(c)** from initially undamaged sample; **(d)** after 5000 e/nm^2 .

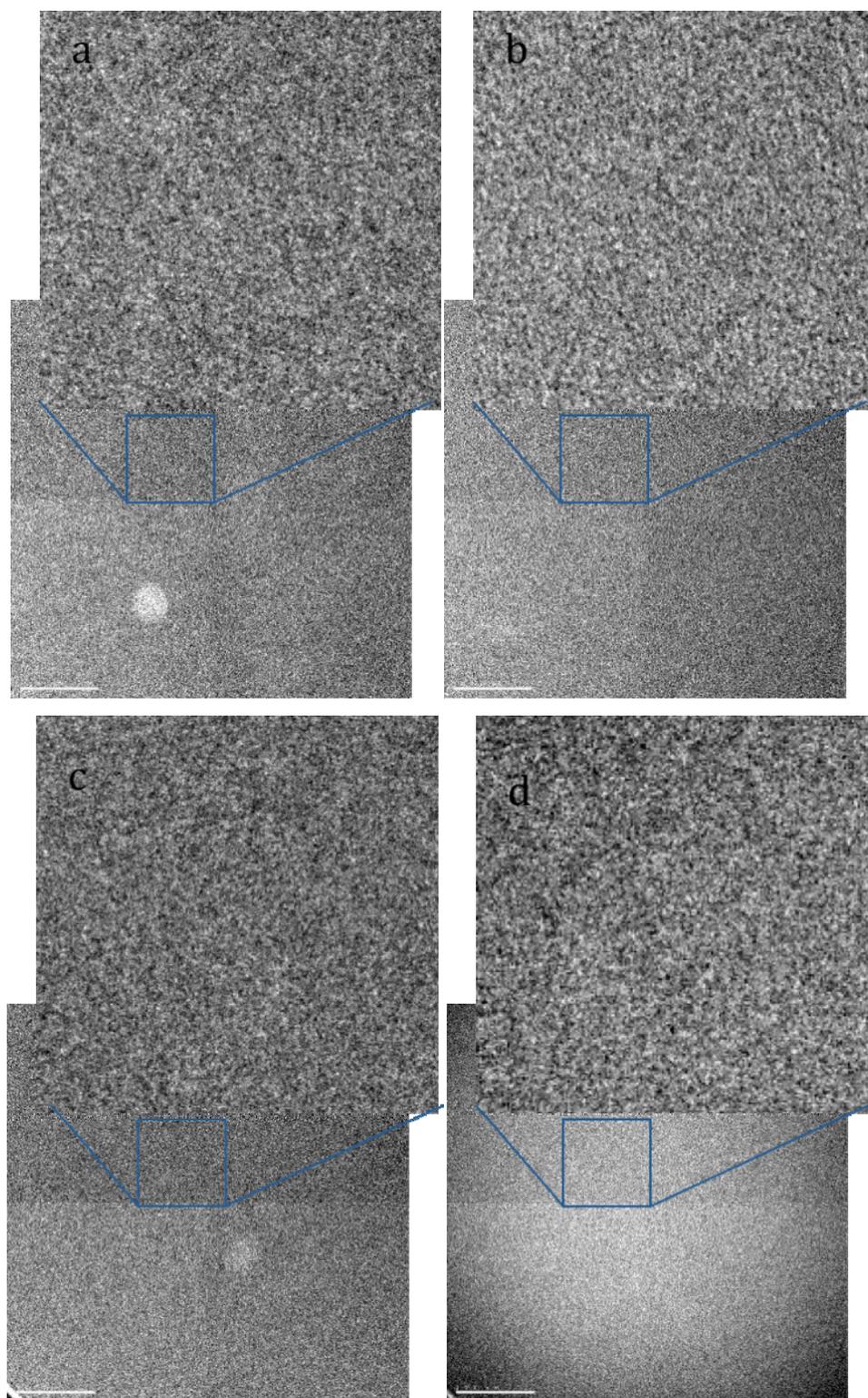
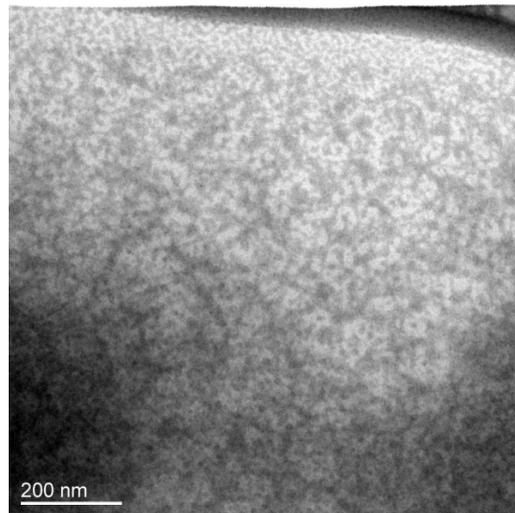


Figure S2. Artifacts in Nafion caused by extended beam irradiation. Sample was exposed to the dose rate of $10000 \text{ e/nm}^2 \text{ s}$ for one minute, resulting in small mass loss after initial thinning but the appearance of substantial phase separation.



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