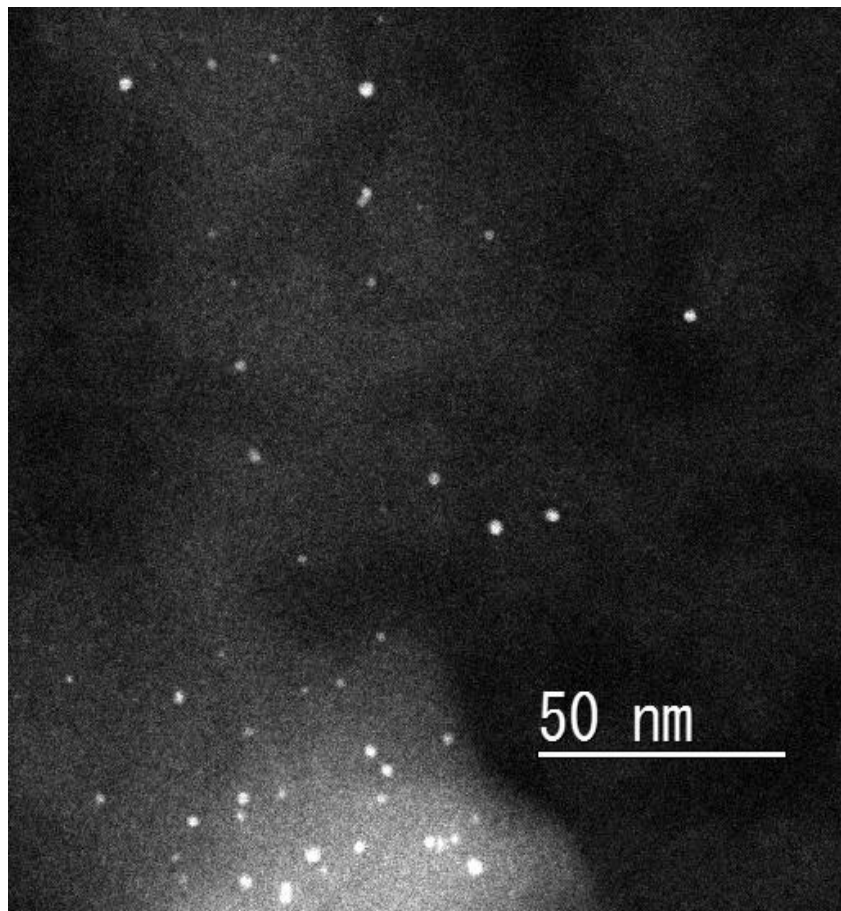
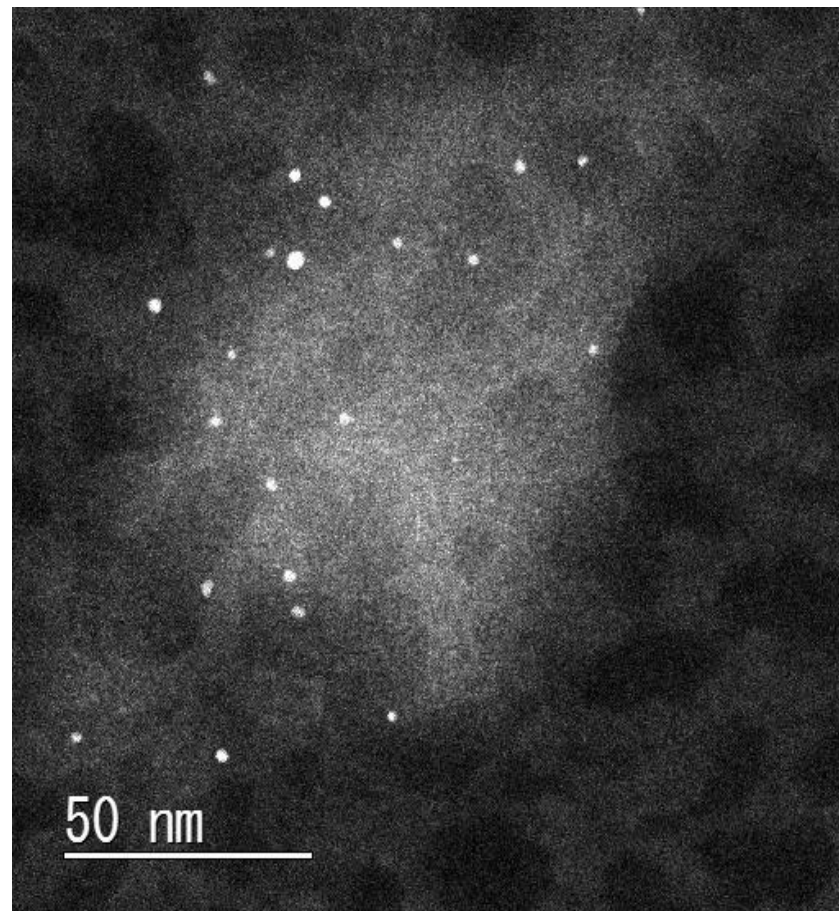


# Supporting information 1

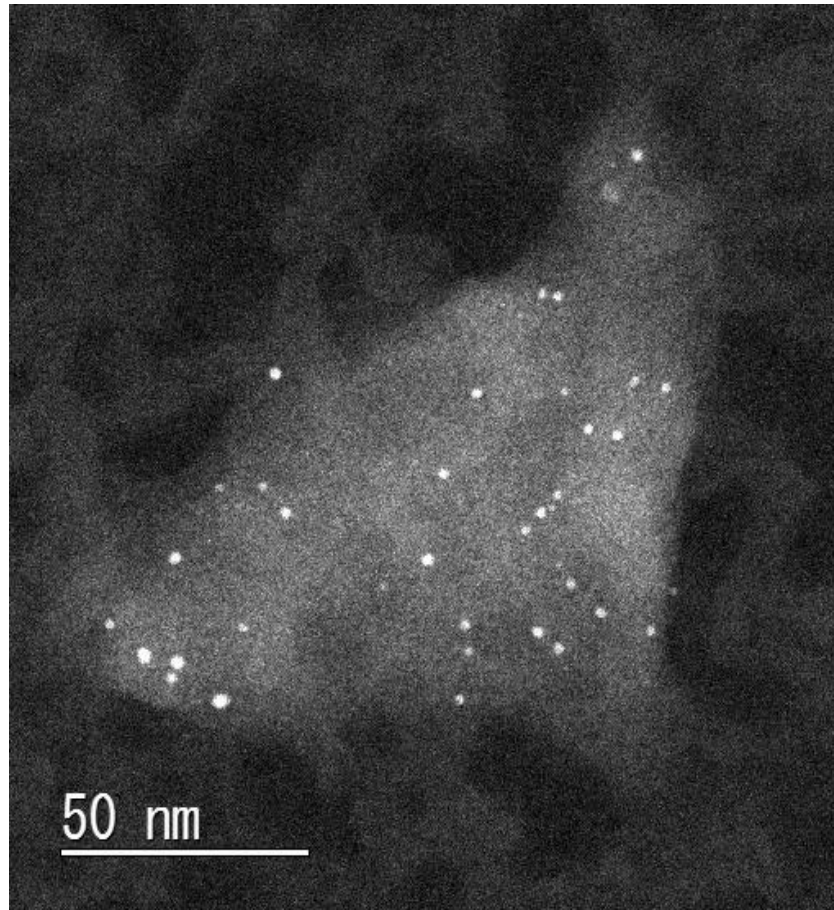
All STEM images for measuring particle size distribution (Catalyst No.1)



(Au+Pd) ion exchange  $\rightarrow$  reduction  
(Catalyst No. 1 in Table 1)  
STEM image 1-1

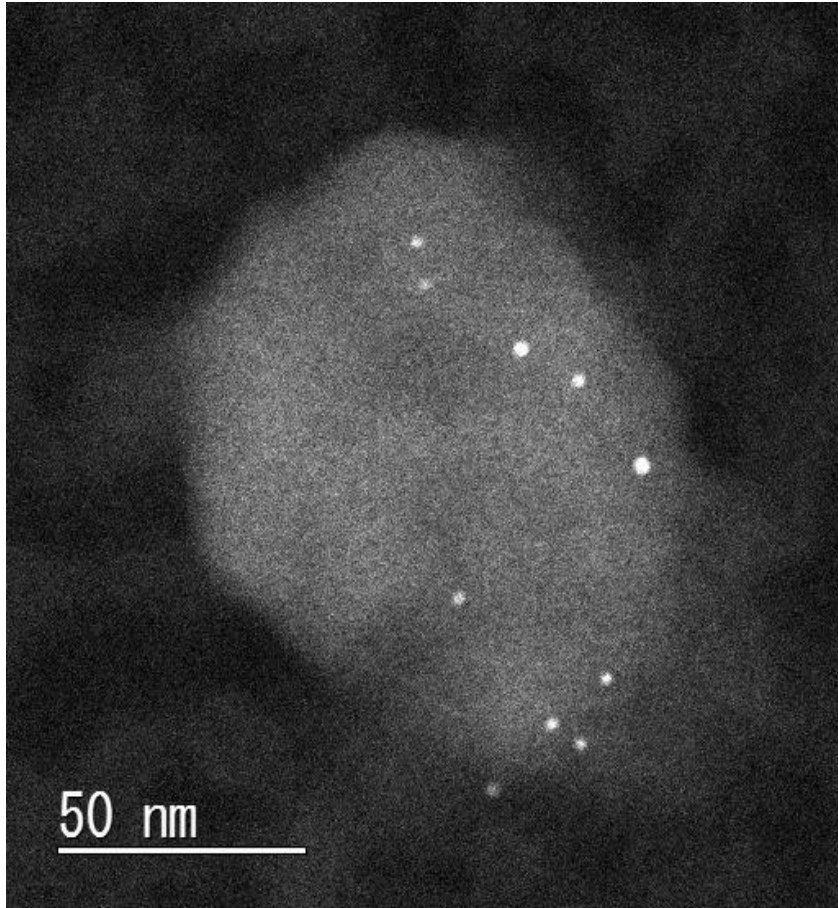


(Au+Pd) ion exchange  $\rightarrow$  reduction  
(Catalyst No. 1 in Table 1)  
STEM image 1-2

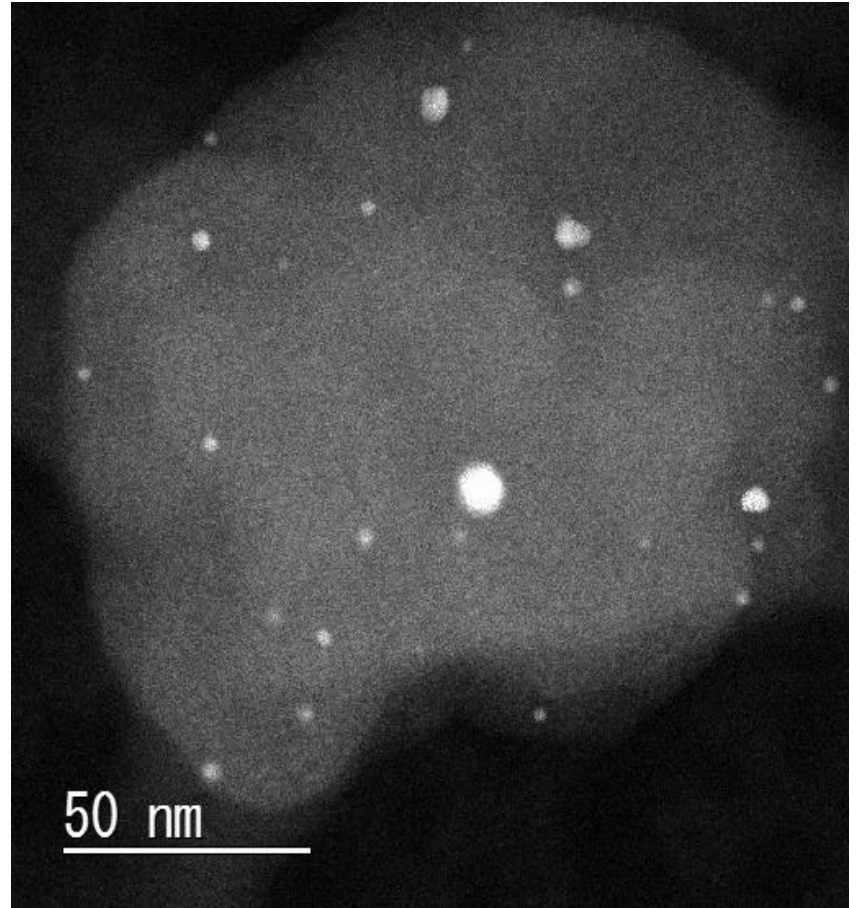


(Au+Pd) ion exchange  $\rightarrow$  reduction  
(Catalyst No. 1 in Table 1)  
STEM image 1-3

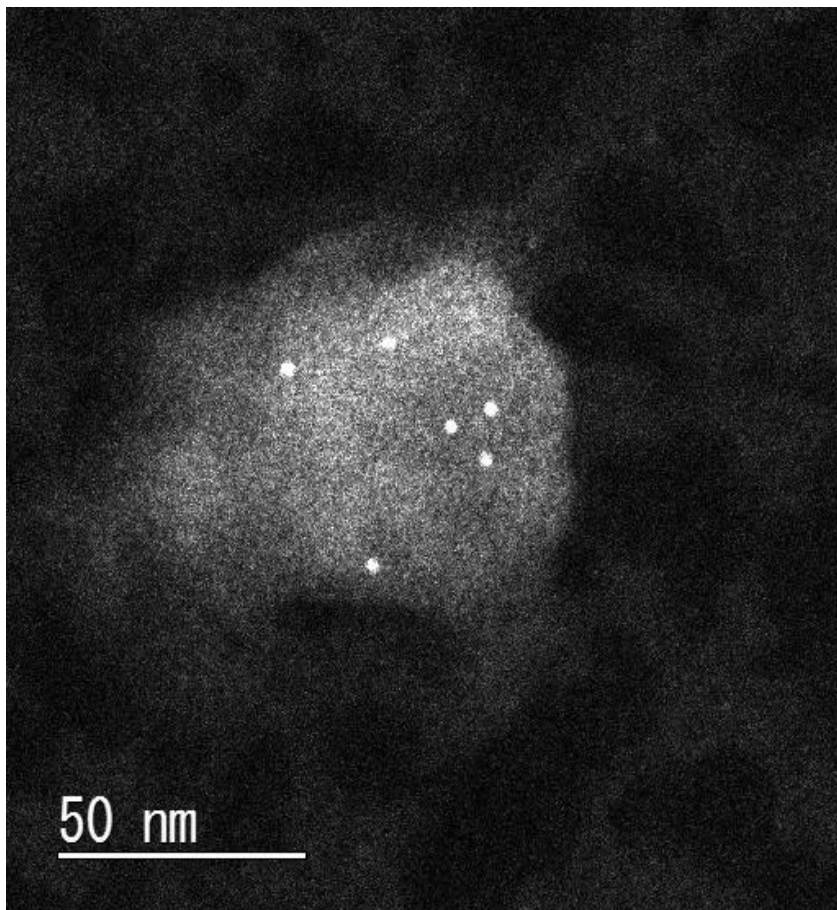
All STEM images for measuring particle size distribution (Catalyst No.2)



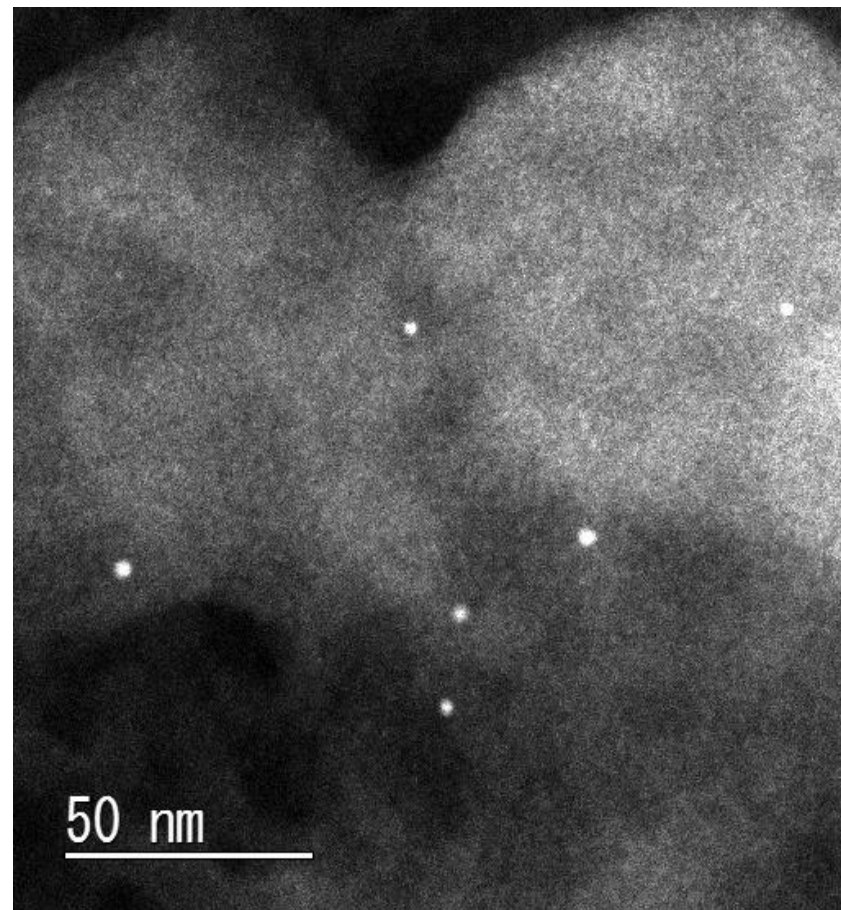
Au ion exchange  $\rightarrow$  reduction  $\rightarrow$   
Pd ion exchange  $\rightarrow$  reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-1



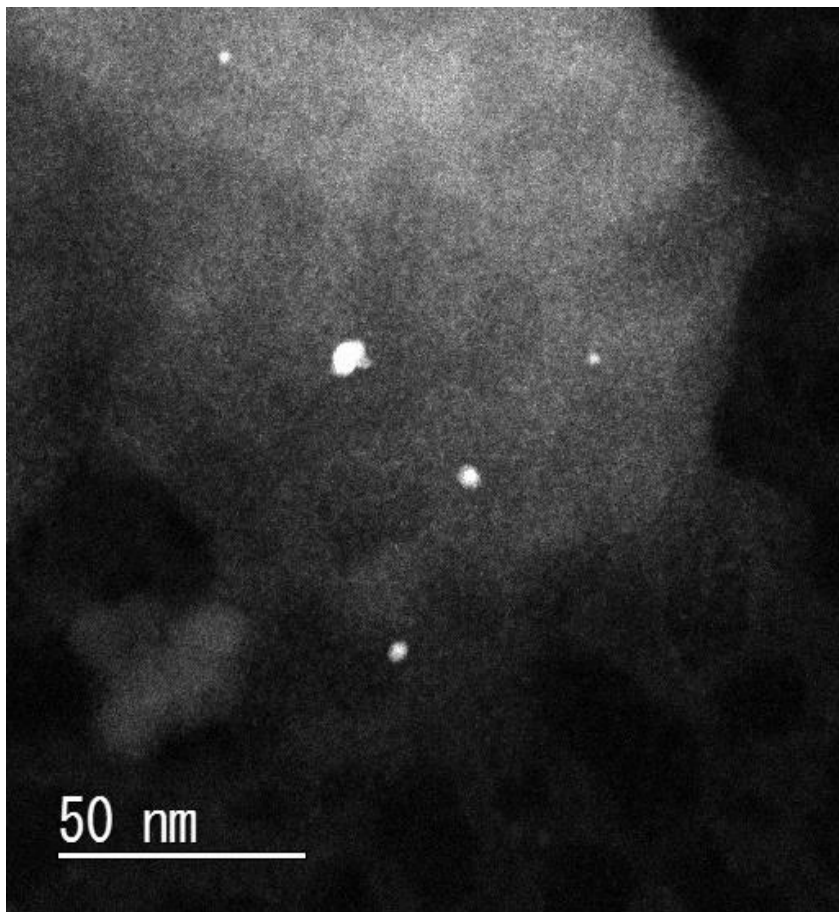
Au ion exchange  $\rightarrow$  reduction  $\rightarrow$   
Pd ion exchange  $\rightarrow$  reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-2



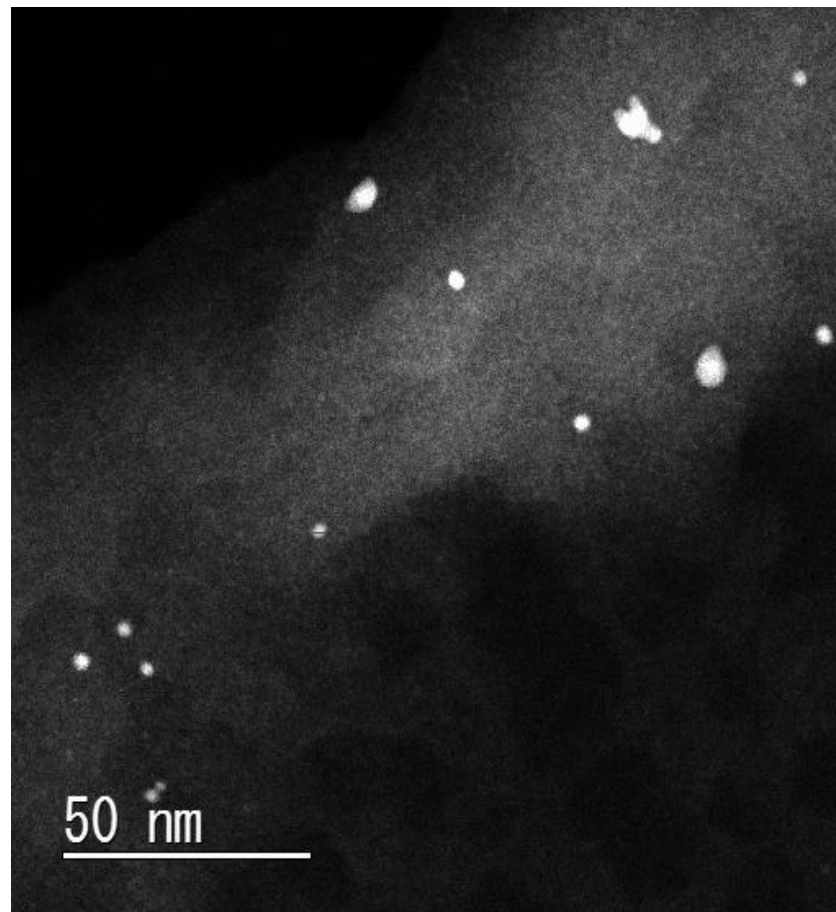
Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-3



Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-4

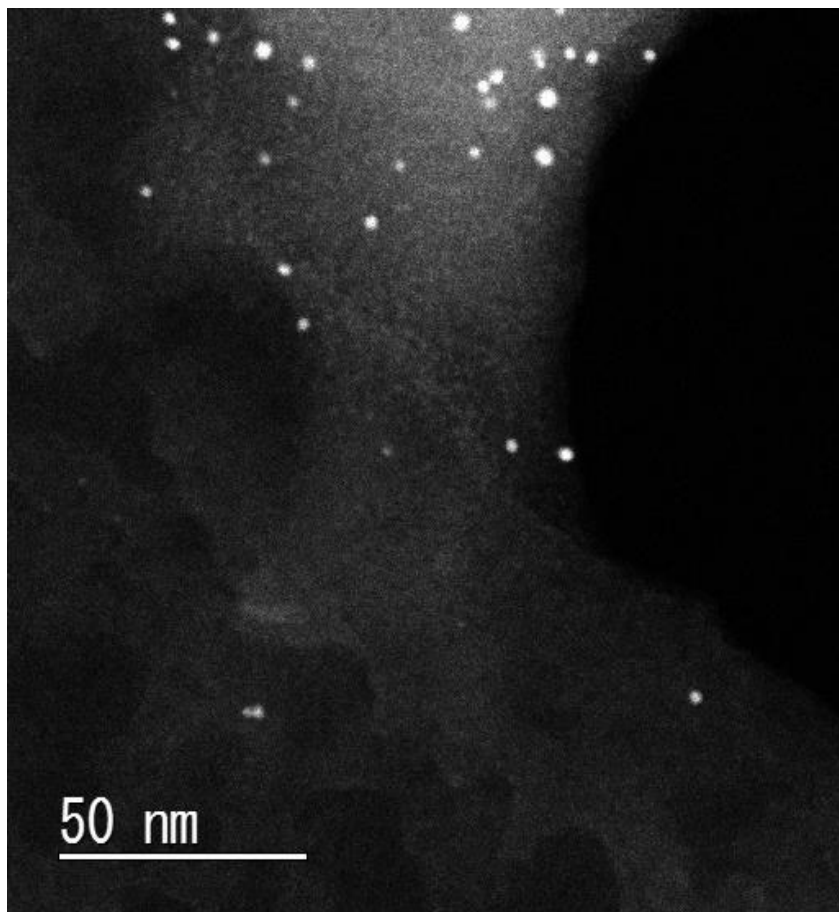


Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-5

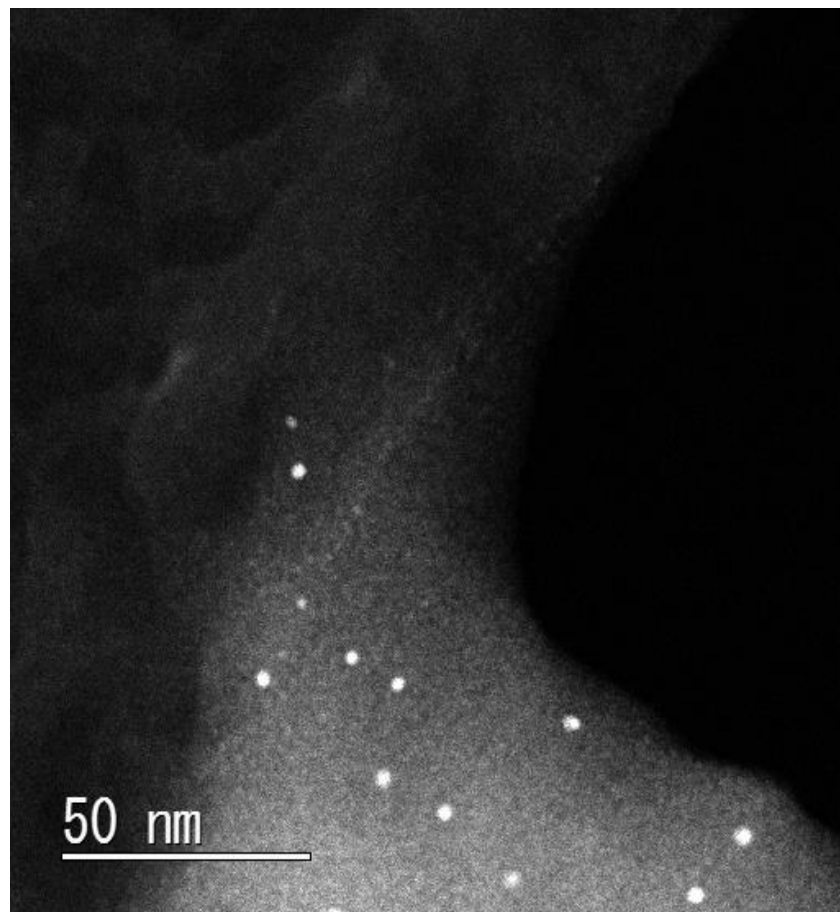


Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-6

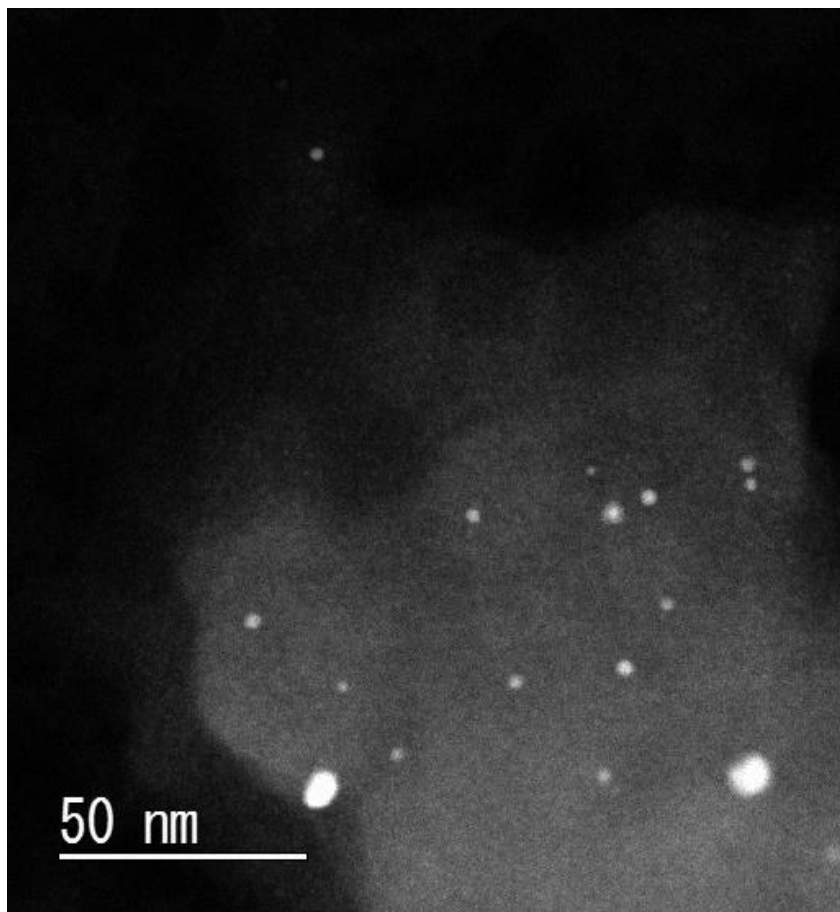




Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-7

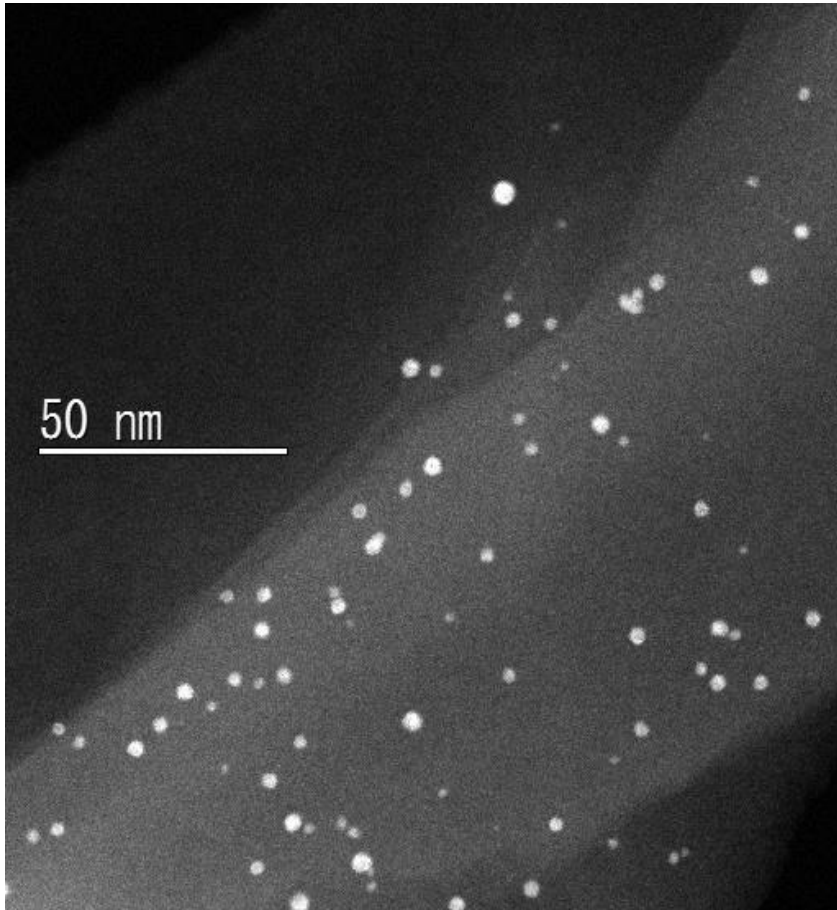


Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-8



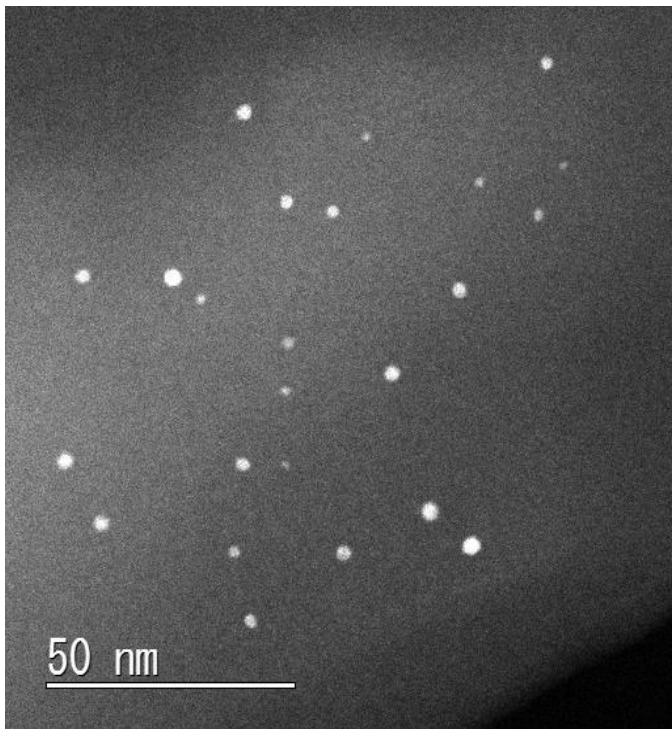
Au ion exchange → reduction →  
Pd ion exchange → reduction  
(Catalyst No. 2 in Table 1)  
STEM image 2-9

All STEM images for measuring particle size distribution (Catalyst No.3)

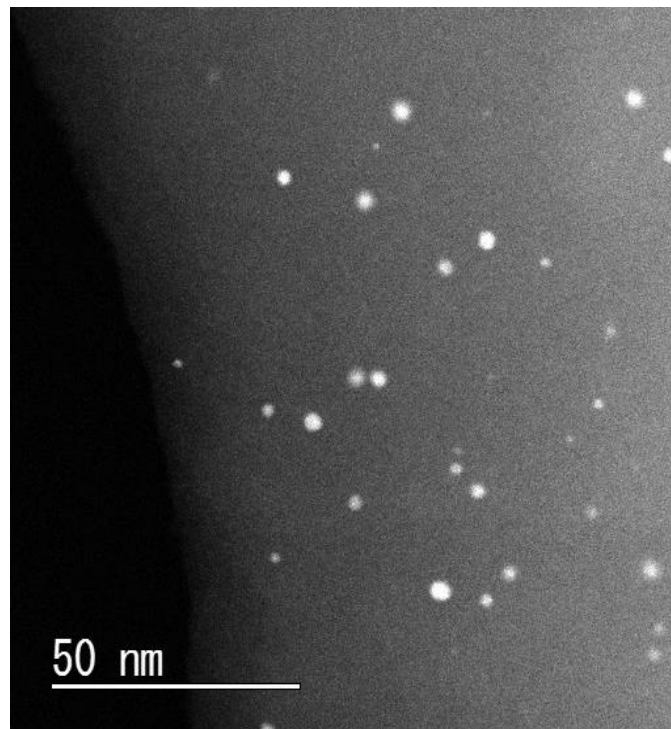


Pd ion exchange → reduction →  
Au ion exchange → reduction  
(Catalyst No. 3 in Table 1)  
STEM image 3-1





Pd ion exchange → reduction →  
Au ion exchange → reduction  
(Catalyst No. 3 in Table 1)  
STEM image 3-2



Pd ion exchange → reduction →  
Au ion exchange → reduction  
(Catalyst No. 3 in Table 1)  
STEM image 3-3