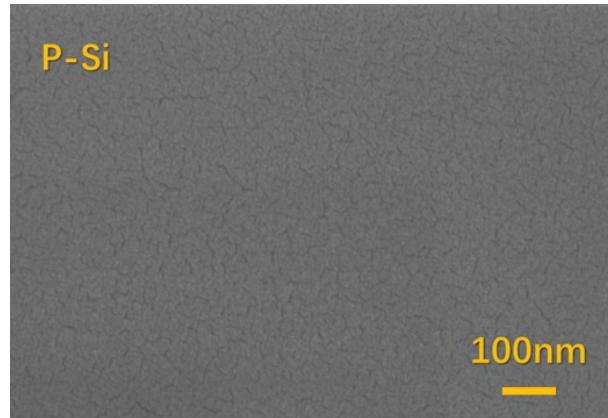
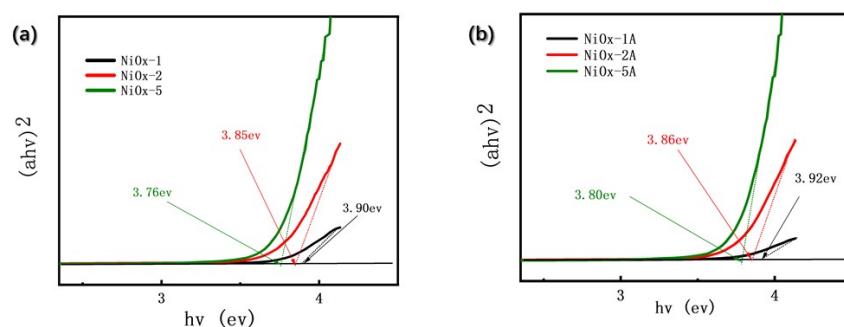


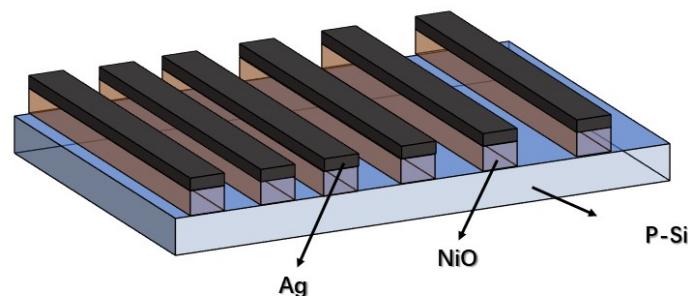
**Supplementary diagram:**



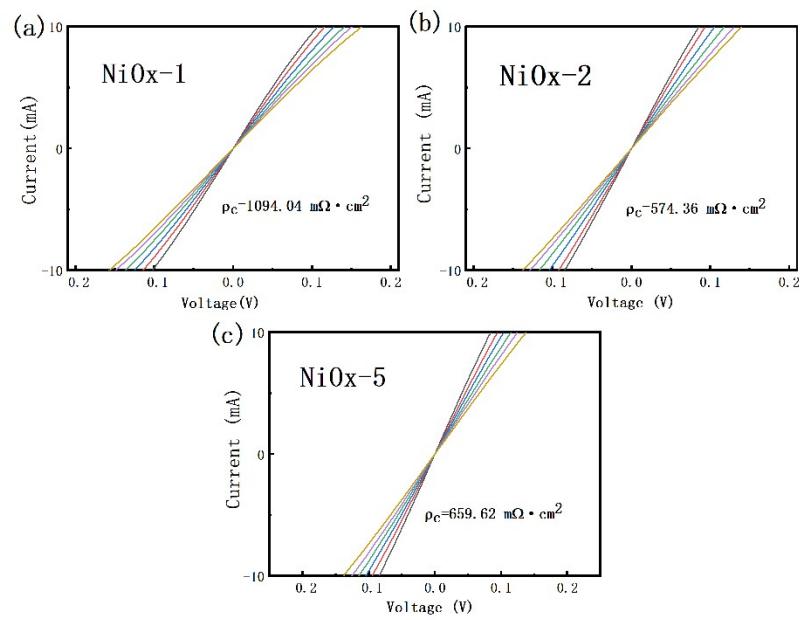
**Fig.S1.** The SEM image of the cleaned P-si.



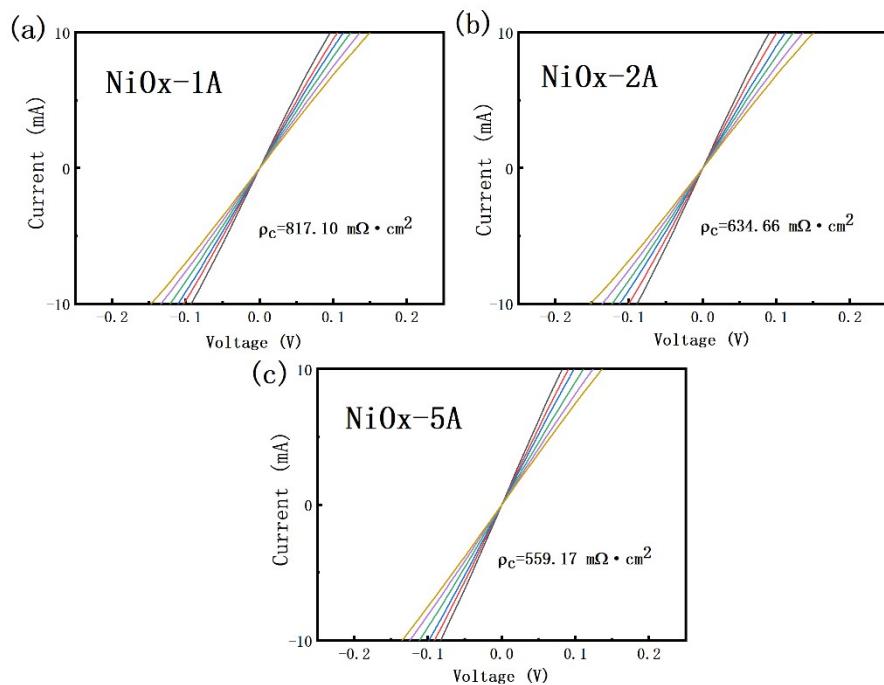
**Fig.S2.** The bandgap widths of different NiOx films



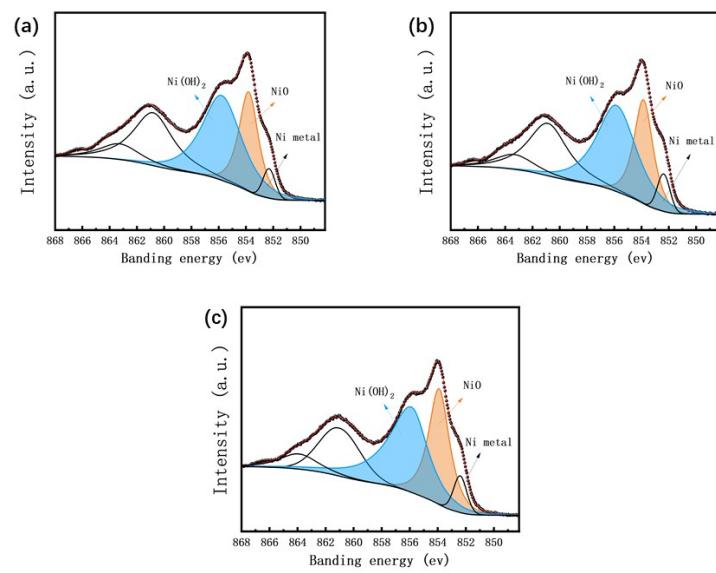
**Fig.S3.** The structures of the test of the contact resistance



**Fig S4 (a)-(d). Contact resistivity test for NiOx-1, NiOx-2, NiOx-5**



**Fig S5 (a)-(d). Contact resistivity test for NiOx-1A, NiOx-2A, NiOx-5A**



**FigS6(a)-(c) XPS test of NiOx-1A, NiOx-2A, NiOx-5A**