

Supplemental material for abstract id: 2837

“Microstructure and Electrical Properties of Conductive Nitride Films Grown by Plasma Enhanced Atomic Layer Deposition with Considerable Ion Bombardment”

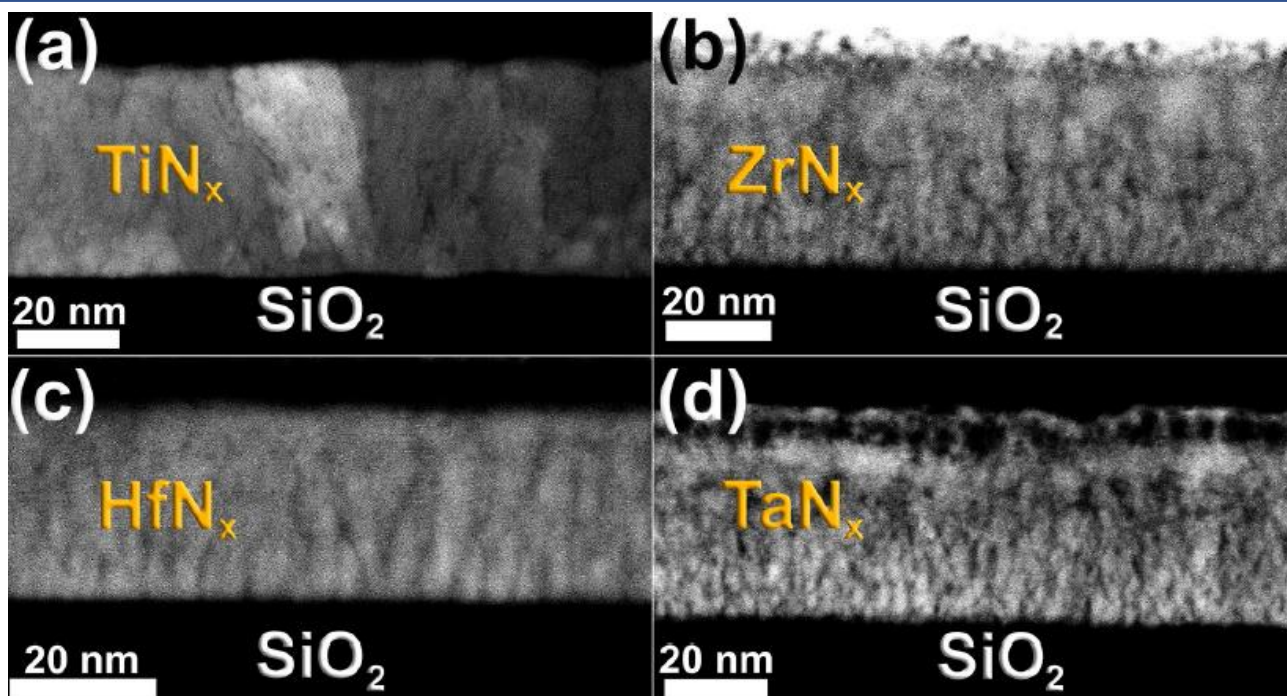


FIG. 1. HAADF-STEM micrographs acquired for (a) TiN_x , (b) ZrN_x , (c) HfN_x , and (d) TaN_x PEALD films. TiN_x films exhibit large columnar grains, whereas the other deposited nitrides consist of smaller grains.

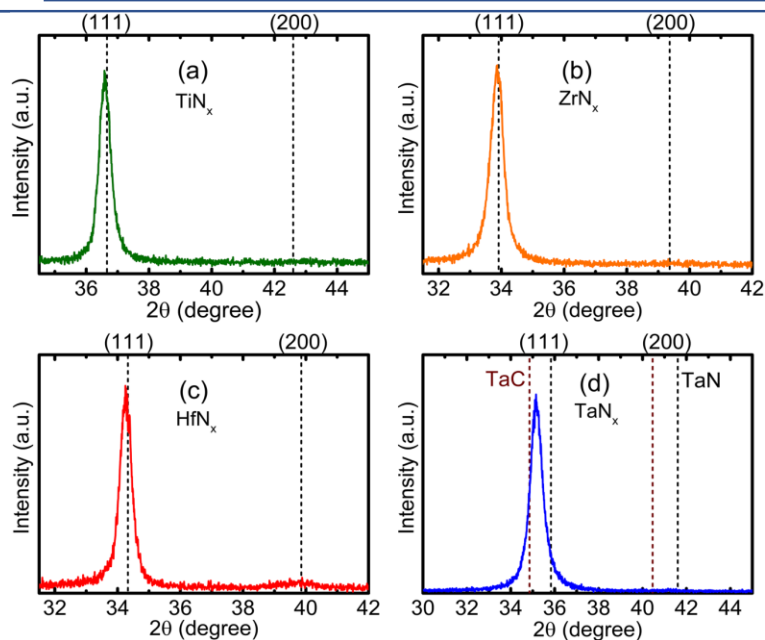


FIG. 2. XRD spectra of (a) TiN_x , (b) ZrN_x , (c) HfN_x , and (d) TaN_x PEALD films obtained by the $\theta/2\theta$ technique. All deposited nitrides are (111) oriented poly-crystalline films.

Table 1. XPS chemical composition and XRR density of films deposited from H_2/Ar plasma

Films	O (at. %)	C (at. %)	N (at. %)	Metal atom (at. %)	Measured density (g/cm ³)	Deviation from theoretical density (%)
TiN	<1.0	8.4	44.0	46.6	5.4	1
ZrNx	1.4	19.6	29.2	49.8	6.1	14
HfNx	<1.0	14	30.1	54.9	10.5	24
TaNx	2.6	18.5	18.2	60.7	12.0	12

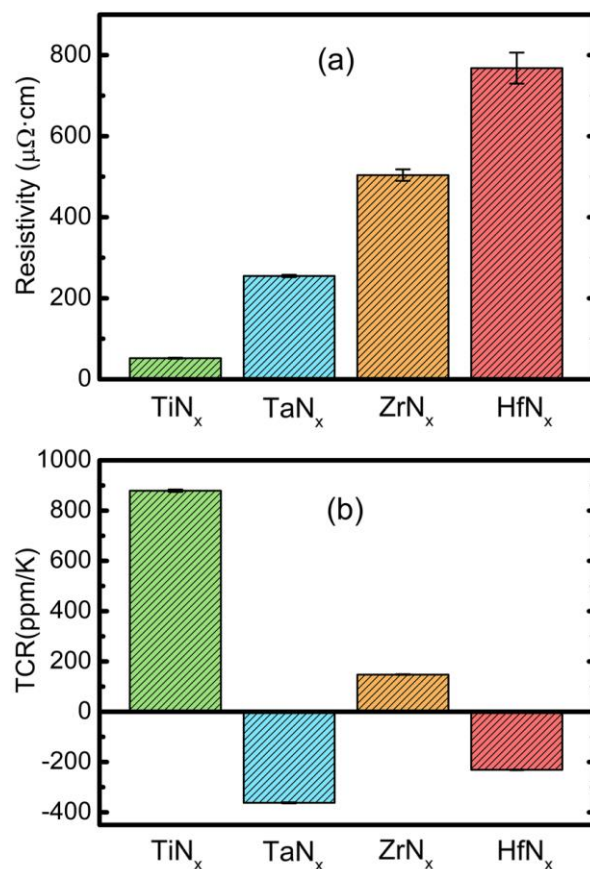


FIG. 3. (a) Resistivity and (b) temperature coefficient of resistance (TCR) of deposited nitride films. The lowest resistivity was obtained for TiN_x films. Negative TCR values (semiconducting behavior) were obtained for TaN_x and HfN_x films.