Supplementary Information

for

Tailoring of surface plasmon resonances in TiN/($Al_{0.72}Sc_{0.28}$)N multilayers by dielectric layer thickness variation

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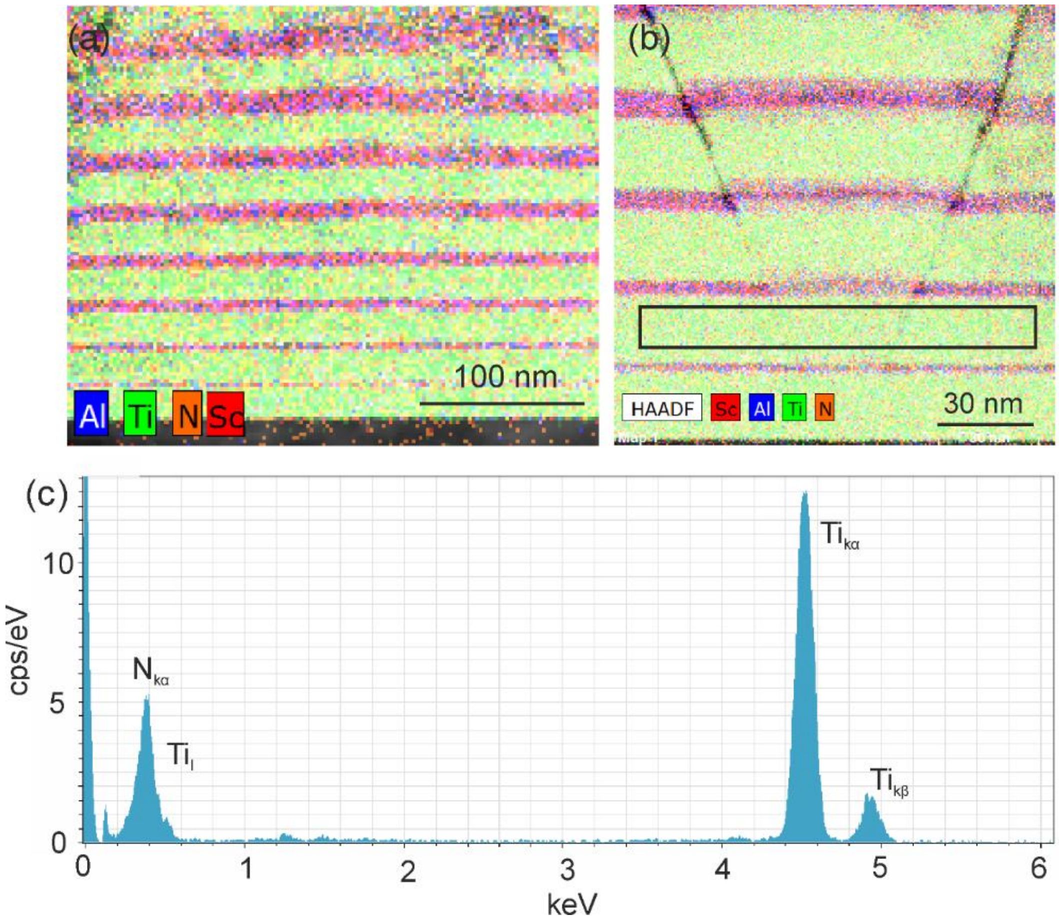
1) EDS mapping

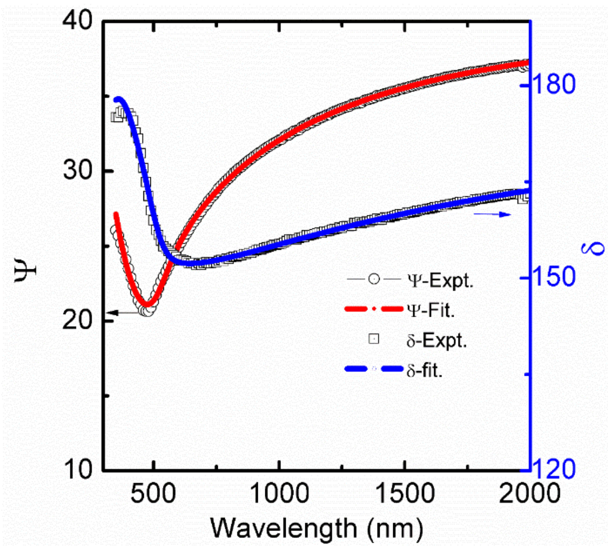
EDS maps were recorded with a Super-X EDS detector system for ultra-high count rates in STEM mode, and EDS maps with total counts well above 1.000.000 have been recorded for quantification to confirm both the TiN and $Al_{0.72}Sc_{0.28}N$ layer composition. Figure S1 (a) and (b) shows two such map of about 250 x 250 pixel, where each pixel in itself represents an entire spectrum. Fig. S1 (c) shows an extracted spectrum for quantification from the TiN-region marked by a rectangle in (b).



Supplementary Figure S1. (a) and (b) show EDS maps of the multilayer recorded at different magnifications (raw data) . (c) shows an integrated spectrum from the region marked by rectangle in (b).

2) Optical measurements and data fitting

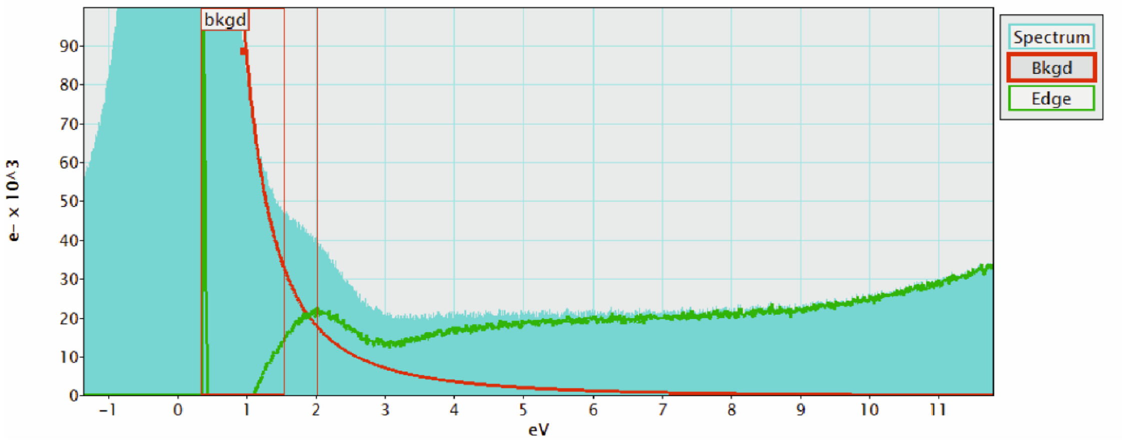
Dielectric permittivities of individual TiN (20 nm thickness) and $Al_{0.72}Sc_{0.28}N$ layers (thicknesses of 5 nm and 30 nm) were measured by spectroscopic ellipsometry (J. A. Woollam Co.). The ψ and δ plots (c.f. Figure S2) were obtained for three different incidence angles, 30°, 50°, and 70°, respectively in the spectral range of 320–2000 nm with an interval of 10 nm. The ellipsometry data were fitted with a Drude model for TiN and a Drude–Lorentz model for the (Al,Sc)N layers. No variation in permittivity was found between the 5 nm and 30 nm film thicknesses.



Supplementary Figure S2. Fitting of the ellipsometry data for TiN based on a Drude model.

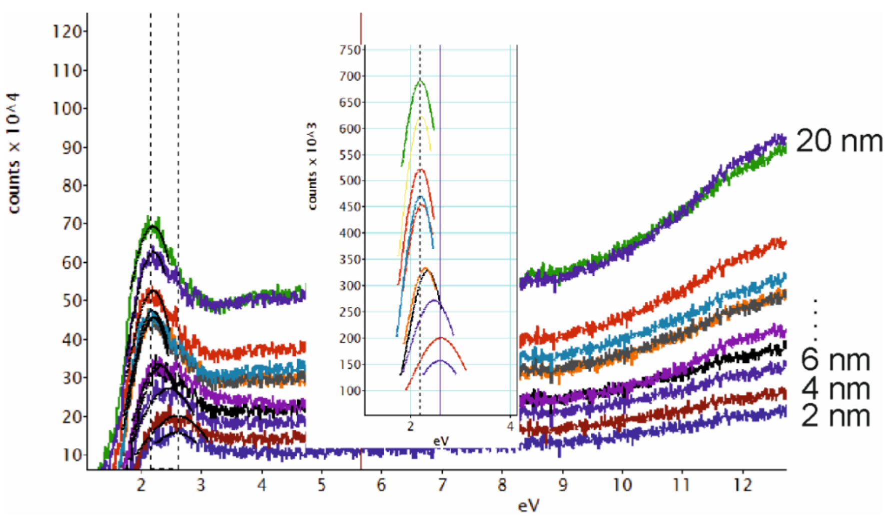
3) EEL spectra acquisition and analysis

Analysis of the low-loss EELS region was done by background removal via fitting a power-law decay function to the ZLP tails (c.f. Figure S3).



Supplementary Figure S3. Background removal via fitting a power-law decay function to the ZLP tails of the TiN interface spectra close to the (Al,Sc)N layer with 20 nm thickness.

After back-ground subtraction, Gauss plots were fitted to the individual peaks for determination of TiN surface plasmon energy Ep, as shown in Figure S4 for all interface spectra. The TiN surface plasmon energy Ep as function of (Al,Sc)N interlayer thickness t decreases from 2.56 eV to 2.16 eV with increase of t from 2nm to 20 nm.



Supplementary Figure S4. Gauss fitting of the background-subtracted TiN interface spectra, with inset showing the Gauss fits only for clarity. The TiN surface plasmon energy Ep as function of (Al,Sc)N interlayer thickness t decreases from 2.56 eV to 2.16 eV with increase of t from 2nm to 20 nm.