Transition Metal Nitride and Oxide Thin Films: Growth and Properties

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Plasmonic materials have a wide range of applications, from energy storage and harvesting to bio-sensing and memory storage devices [1–3]. However, the archetypal plasmonic materials gold and silver are limited in their applicability, displaying poor thermal stability, limited spectral tunability, and incompatibility with standard CMOS fabrication processes.

Consequently, refractory plasmonic materials are capable of with-standing high operating temperatures and can include refractory metal elements (e.g. W, Mo, Ti) in addition to transition metal oxides and nitrides (e.g $SrMoO_3$, $SrNbO_3$, $SrRuO_3$, TiN, NbN).[4] Transition metal oxides (TMOs) and transition metal nitrides (TMNs) are of particular interest as they are capable of delivering tailorable optical properties via deposition-controlled variations in film stoichiometry, morphology and strain.[5] Of the TMNs investigated, titanium nitride (TiN) has been the subject of recent research as its optical constants are comparable to gold and it also displays high temperature stability and a tuneable plasma frequency.[6] However, other binary and ternary TMNs including NbN, TaN, ZrN and TiZrN also hold promise for use within plasmonic applications at varying wave-lengths and operating conditions. [7]

In this paper, the mechanism of formation of transition metal nitride and oxide thin films and their optical properties with tunable epsilon-near-zero (ENZ) behaviour will be discussed. We will present the technological conditions for deposition of thin films with unusual double ENZ frequencies and will show that they can be modified by changing the film deposition conditions. Thus allowing one to fabricate, control and engineer tunable plasmonic and metamaterial devices and surfaces, using CMOS compatible technology.

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