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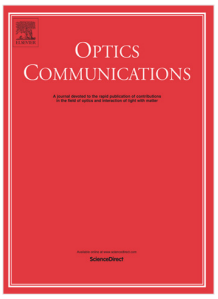

Surface plasmon amplification in refractory transition metal nitrides based nanoparticle dimers

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Surface Plasmon Amplification in Refractory Transition Metal Nitrides based Nanoparticle Dimers

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Abstract

Aggregates of plasmonic nanoparticles (NPs) are known to show greater electric field amplification, multiple resonant peaks, and precisely controlled spectral tuning compared to their isolated counterpart. The ability of localized surface plasmon mediated electric field amplification is an important criterion for a plasmonic system to act as an efficient **S**urface **E**nhanced **R**aman **S**cattering (SERS) substrate. Conventional coinage metals like gold (Au), silver (Ag) and copper (Cu) are most widely used SERS substrates, mainly due to their well established synthesis process and large Raman signal amplification. However, there is a pressing need to expand the list of plasmonic materials feasible for SERS substrates to match the exponential growth in SERS research. Identification of new plasmonic substrates will reduce the dependence on conventional plasmonic materials and SERS applications will extend into unexplored spectral regions. Moreover, one can circumvent the limitations arising due to the intrinsic nature of conventional plasmonic materials. **R**efractory **T**ransition **M**etal **N**itrides (RTMN) such as zirconium nitride (ZrN) and titanium nitride (TiN) has emerged as viable alternatives to coinage metals due mainly to, high electron conductivity, suitability for high temperature applications, optical response in Vis-NIR region, flexible spectral fine-tuning, and bio/CMOS compatibility. To the best of our knowledge, this article presents first-ever theoretical assessment of ZrN and TiN nanoparticle dimers for their suitability in enhancing electric field. Moreover, the role of nanoparticle size, embedding medium and inter-particle separation is quantified through fitting relations whose usefulness is demonstrated by designing nitrides based SERS substrates for selected wavelengths. The present work will provide handy tools to the designers and manufacturers.

Keywords: plasmonics, nanoparticles, sensors, refractory nitrides, SERS, Raman scattering.