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Indium for deep-UV plasmonics: Surface-enhanced Raman scattering

RIKEN [1], Osaka University [2], °Yasuaki Kumamoto[1], Yuika Saito[2], Atsushi Taguchi[1,2], Mitsuhiro Honda[2], Koichi Watanabe[2], Satoshi Kawata[1,2]

E-mail: kumamoto@riken.jp

Plasmonics in the deep-UV spectral range (λ =200-300nm) has been eagerly studied in the recent decade. In this range, Al has been considered as the only reliable, efficient metal supporting surface plasmon resonances (SPRs) while SPRs can't occur in Au and Ag[1]. In the study that will be presented in this talk, we will introduce indium (In) as another choice of metal for plasmonics in the deep-UV[2]. As used to be the case for Au and Ag that together have contributed to development of plasmonics in the visible spectral range, In will contribute together with Al to development of the plasmonics in the deep-UV.

Among a various kinds of metals, we focused on In by considering that the dielectric function of In [3] indicates the potential of In as a low-loss, high-gain deep-UV plasmonic metal. We examined the potential of In quantitatively using experiments and simulations. We first prepared In-coated substrates. In-coated substrates were reproducibly, easily prepared via thermal vapor deposition of In to fused silica glass substrates in a vacuum chamber. The substrates were filled with well-separated grains of In (see Fig. inset) and exhibited absorption bands due to SPRs in the deep-UV. We used prepared In-coated substrates for surface-enhanced resonance Raman scattering (SERRS) measurements at λ =266 nm excitation. Fig. shows an obtained SERRS spectrum. Sample was an adenine thin film coated over an In substrate. A Raman spectrum of an adenine film coating a bared fused silica glass substrate with the same thickness as one coating In substrates was also measured. In comparison, one of Raman bands seen in the SERRS spectrum exhibits 11 times higher intensity than the corresponding Raman band in the Raman spectrum obtained from the bare fused silica glass sample. In order to understand this enhancement, we performed electromagnetic simulations by FDTD calculations. The simulation derived a field distribution over the In substrate. The result showed that the strongly enhanced field is locally generated on the In substrate, indicating that experimentally observed enhancement is attributable to electromagnetic field enhancement. These results are supportive to prove In to be an efficient, easy-to-use metal for deep-UV plasmonics.

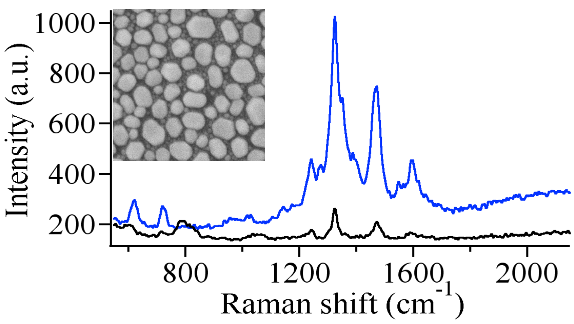

Fig. Deep-UV excitation Raman spectra of adenine coating (upper) an In-coated, and (lower) a bare fused silica glass substrate. The inset shows 1μm x 1μm SEM image of the In substrate.

References

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