Quantitative near-field characterization of surface plasmon polaritons on single-crystalline gold platelets

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Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

Quantitative near-field characterization of surface plasmon polaritons on single-crystalline gold platelets

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Abstract: The subwavelength confinement of surface plasmon polaritons (SPPs) makes them useful for various applications such as nanoplasmonic circuits, light generation and sensing. Scattering-type scanning near-field optical microscopes (s-SNOM) allow the direct measurement of the SPPs with high spatial resolution. However, in a reflection configuration, their full quantitative characterization is challenging because of complex wave patterns resulting from the interference between several excitation pathways. In a previous study, it has been shown that the wavelength of the SPPs launched by a s-SNOM tip (called tip-launched SPPs) could be retrieved by analyzing the s-SNOM signal far from the edges of the platelets [1]. Here, we present results from the interferometric near-field measurements of both the amplitude and phase of SPPs on large single-crystalline gold platelets in the visible spectral range [2]. We study systematically the influence of the angle of the incident light on the SPPs. We find that the signal of the tip-launched SPPs is best disentangled from other signals at grazing incident angle relative to the platelet's edge. Moreover, we introduce a simple theoretical model to explain the $\pi/2$ phase shift observed between the SPP amplitude and phase profiles. Using this model, the wavelength Λ^{tl} and in particular the propagation length $L_{\mathrm{p}}^{\mathrm{tl}}$ of the tip-launched SPPs are retrieved by isolating their signals far from the edges. Our experimental results are in excellent agreement with our model using gold refractive index values from the literature. The presented method to fully characterize the SPP complex wavevector could enable the quantitative analysis of polaritons occurring in different materials in the visible range.

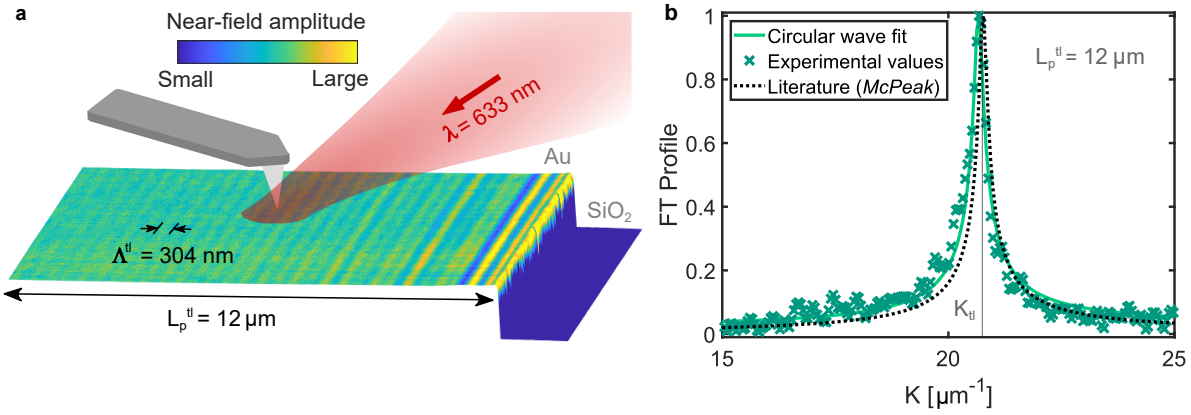

Fig. 1: Experimental details and main result. (a) Simplified schematic of the s-SNOM measurement. The near-field amplitude from one of our measurements is shown on the gold surface. Λ^{tl} is the SPP wavelength and $L_{\mathrm{p}}^{\mathrm{tl}}$ is the propagation length. (b) Fourier transform of the profile extracted from the near-field amplitude dispayed in (a). K_{tl} is the SPP wavevector

References

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