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Supplementary Information for efficient unidirectional launching of surface plasmons by a cascade asymmetric-groove structure

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A detailed comparison with other unidirectional SPP launchers in which the SPP launching efficiencies have been experimentally acquired.

In Ref. 7, Radko *et al.* characterize the efficiency of unidirectional SPP launching with periodic (800 nm) arrays of gold ridges on a thin gold film illuminated with a focused laser beam. At the resonant wavelength of 816 nm, a maximal unidirectional SPP launching efficiency of 0.45 is observed in an eleven-ridge array by adjusting the beam position. The lateral dimension of the eleven-ridge array is 8.3 μm, which is approximately ten times the incident wavelength. The extinction ratio reaches ~35. To obtain a unidirectional SPP launching efficiency of not less than 0.4, the least number of gold ridges is five which in total renders the structure's lateral size four times larger than the wavelength.

In Ref. 9, Baron *et al.* report on the design and experimental observation of a highly efficient unidirectional SPP launcher composed of eleven subwavelength grooves, each with a distinct depth and width. Under normal illumination by a focused Gaussian beam, unidirectional SPP launching with an efficiency of at least 52% is achieved experimentally. The extinction ratio reaches 47. The total lateral dimension of the device is 7.7 μm, which is approximately ten times the incident wavelength (800 nm).

In Ref. 20, Pors *et al.* propose a design, by arranging 6 1D or 6×6 2D SPP-coupler super cells into arrays, that converted incident light to SPPs with an experimental efficiency of 27% and extinction ratio of more than 100. The size of the device is 8.8 μm, which is approximately six times the incident wavelength (1500 nm). However, sample fabrication is complex according to the engaged Au/SiO_2/Au-strip structure.

In Ref. 21, Li *et al.* numerically demonstrate an ultra-broadband and efficient SPP excitation device by adopting identical deep-subwavelength slits of subwavelength period. The period and number of slits adopted in experiments are 240 nm, 15 and 480 nm, 8 for launcher 1 and 2, respectively, while the incident wavelength ranges from 800 nm to 920 nm. The maximal efficiency experimentally acquired is 31.9% and the lateral dimension (~3.4 μm) of the device is still more than four times the wavelength.

The current work arranges two identical asymmetric grooves. The measured maximal SPP launching efficiency is at least 0.46 and the extinction ratio is 40. The total lateral dimension of the device is only 1.1 μm, which is approximately 1.5 times the incident wavelength (760 nm). Compared with previous reports, our study manages to greatly reduce the device size, which is highly preferred in practical applications. Meanwhile, a high unidirectional SPP launching efficiency (larger than that in Ref. 7, 20, 21 and only slightly smaller than that in Ref. 9) is still achieved. Besides, our structure also presents broadband response (the efficiency stays above 0.35 for wavelength from 720 nm to 840 nm) and is easy to fabricate. These characteristics make our structure quite suitable for practical applications.

A brief summary of the maximal unidirectional SPP launching efficiencies experimentally acquired and the corresponding device sizes is provided in the following table.

	Ref. 7	Ref. 9	Ref. 20	Ref. 21	**Our work**
measured efficiency	~ 45%	≥ 52%	~ 27%	~ 31.9%	**≥ 46%**
device size	> 4λ	~ 10λ	~ 6λ	~ 4λ	**~ 1.5λ**

(λ represents the incident wavelength)