Supporting Information for

Nano-imaging of low-loss plasmonic waveguide modes in graphene nanoribbon

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1. Graphene nanoribbon edge roughness

We have carried out scanning tunneling microscopy (STM) of the graphene nanoribbons prepared by the dry etch method, and the results are shown in Fig. S1. These graphene nanoribbons are on top of a WS2/WSe2 moiré superlattices in the STM study. The GNR edges show a roughness at the level of 1 to 2 nm. In addition, the AFM nanoribbon prepared by dry etch is extremely clean. We believe the low edge roughness and the high cleanness of the nanoribbons are essential to realize the high quality plasmon.

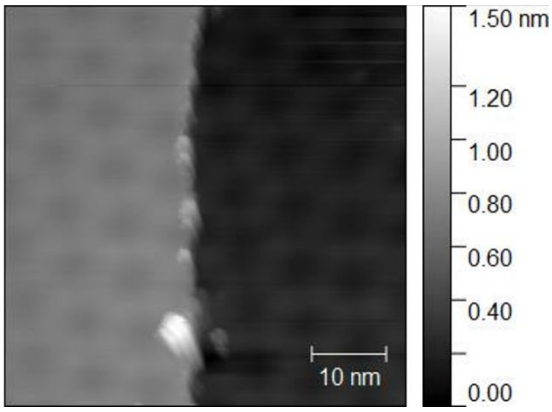

Figure S1. STM image of the GNR edge located on WS2/WSe2 moiré heterostructure surface. The left bright regions correspond to the GNR part while the right dark regions correspond to the WS2/WSe2 moiré heterostructure part. The STM image show an edge roughness at 1.5 nm in the GNR.

2. Estimation of Fermi energy in graphene nanoribbon

The Fermi energy are calculated from the carrier density by $\mathrm{E_F} = \hbar \mathrm{V}_F \sqrt{\pi \mathrm{n}}/e$, $\mathrm{V}_F = 1 \times 10^6\ \mathrm{m/s}$ is the Fermi velocity. $\hbar$ and e are the reduced Plank constant and electron charge, respectively. The carrier density, n, is obtained by $\mathrm{n} = \mathrm{C_{total}} \times (\mathrm{V_g} - V_0)$, where $\mathrm{V_g}$ is the gating voltage

applied to the device and V_0 is the charge neutrality point. The total geometric capacitance per unit area is calculated from the expression $\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$, where $C_1 = \epsilon_0 \varepsilon_{r1}/d_1$ and $C_2 = \epsilon_0 \varepsilon_{r2}/d_2$ are the capacitance per unit area of SiO_2 and hBN, ϵ_0 is the vacuum permittivity, $\varepsilon_{r1} = \varepsilon_{r2} = 3.9$. For the device we measured in Figure 2 in the manuscript, d_1= 285 nm and d_2= 30 nm. The experiment and simulation results in Fig.4a in the manuscript have the best fit when $V_0 = -10$ V.