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Supplementary Information

THz Surface Plasmons in Wide and Freestanding Graphene Nanoribbon Arrays

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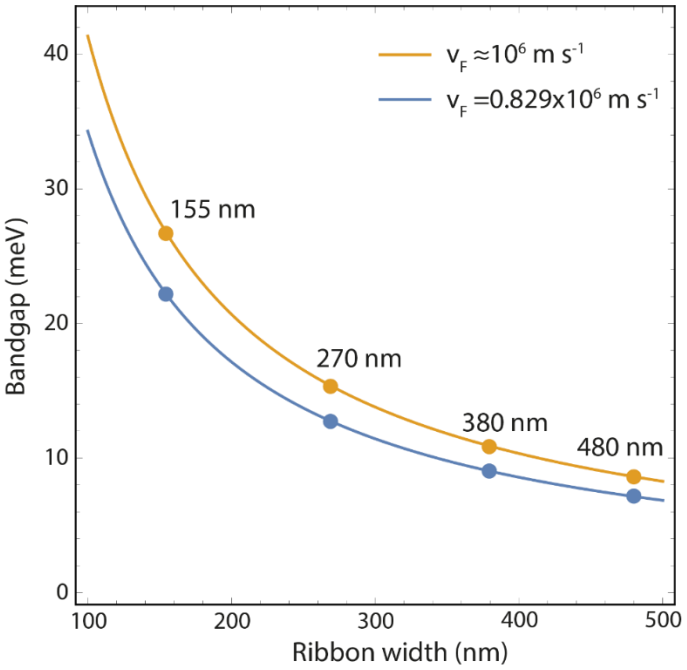

Figure S1. Bandgap (Δ) as a function of the ribbon width (w), considering the charge carrier velocity computed by DFT-LDA ($v_F = 0.829 \times 10^6$ m/s) (Ref. [25] in the main text) and the conventional value widely used ($v_F \approx 10^6$ m/s) (Ref. [28] in the main text). Markers represent the GNR systems under study and continue lines are the fitting curve using Equation 2 (in the main text).

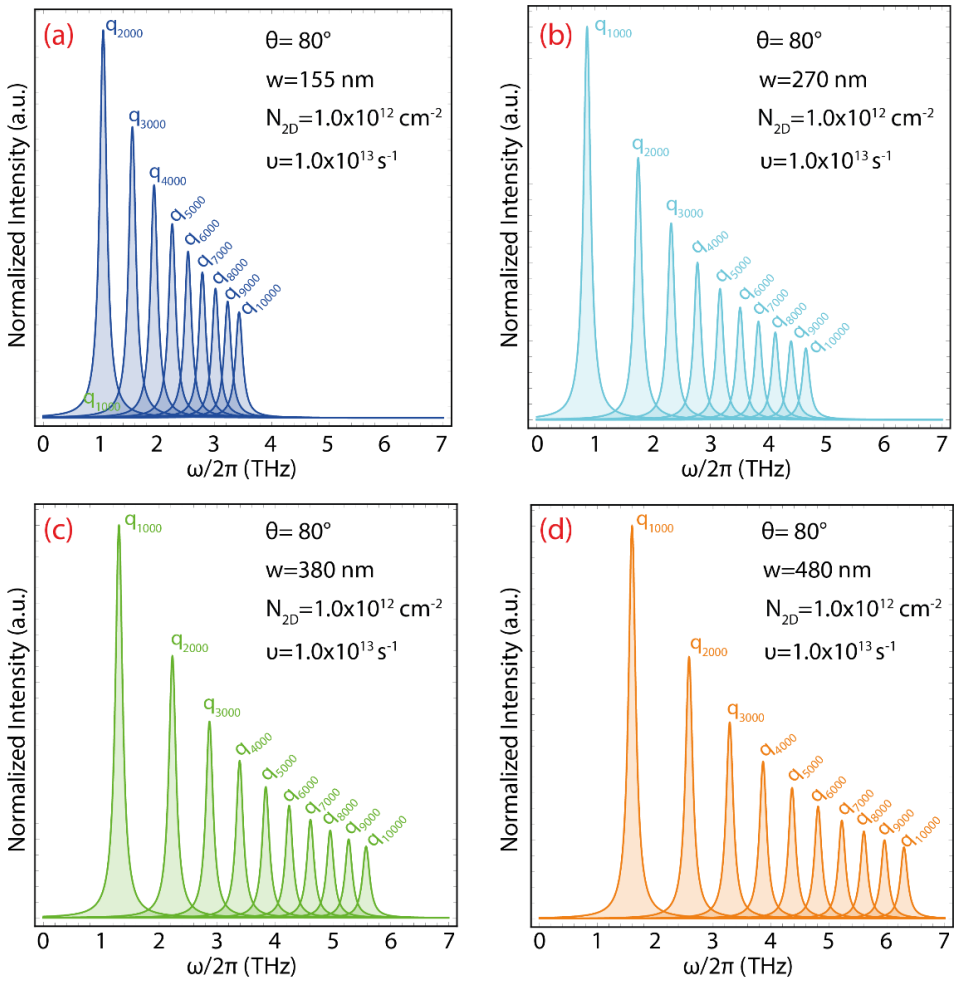

Figure S2. Plasmon frequency ($\omega/2\pi \leq 7$ THz) (using $\theta = 80$, $N_{2D} = 1.0 \times 10^{12}$ cm^{-2}, $\nu = 1.0 \times 10^{13}$ s^{-1}, and $v_F = 0.829 \times 10^6$ m/s) for selected q values from 1000 to 10,000 cm^{-1}, with different ribbon widths: (**a**) $w = 155$ nm, (**b**) $w = 270$ nm, (**c**) $w = 380$ nm, and (**d**) $w = 480$ nm. Plasmon spectra were constructed using the Lorentz line shape function to a maximum value of 1, setting the full width at half maximum to 0.2, and the corresponding transition frequency was taken from Table 4 (in the main text) for the selected q values. A conventional exponential decay function is adopted for the dispersion of the plasmon spectra.

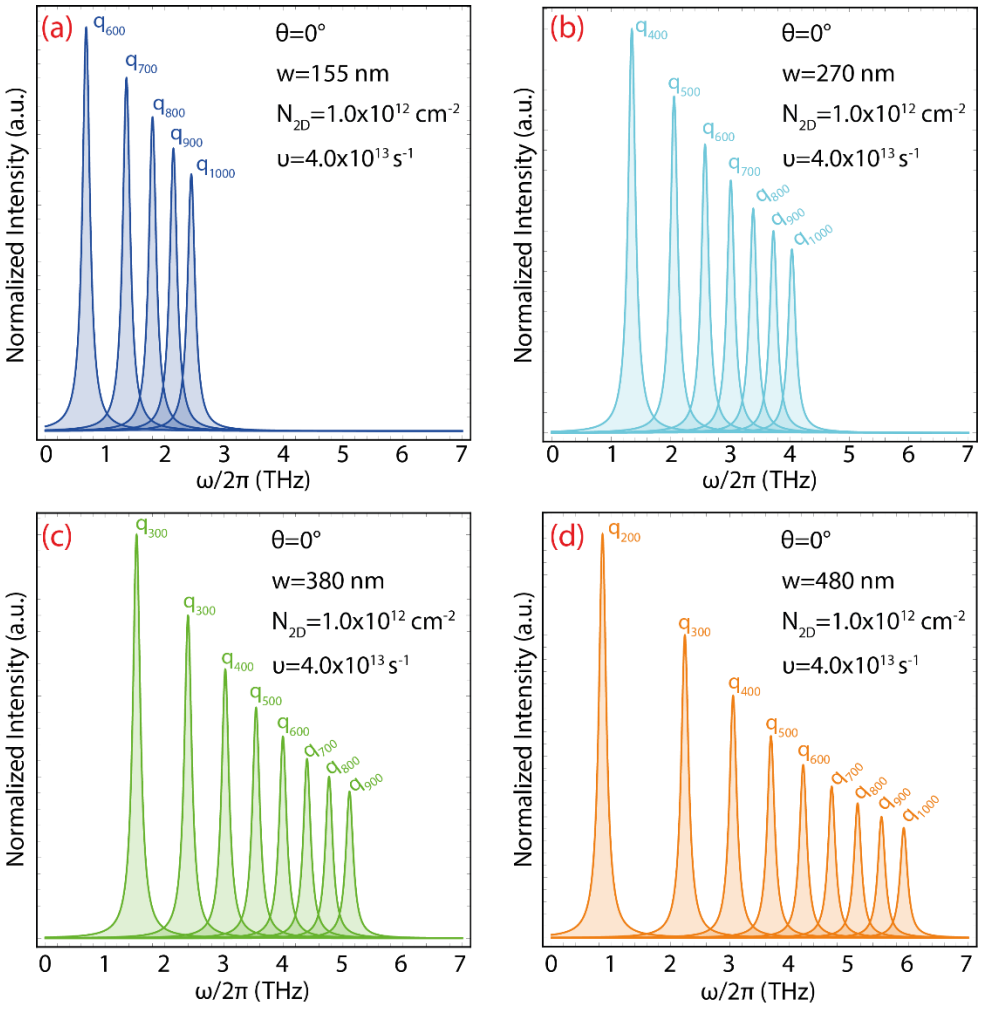

Figure S3. Plasmon frequency ($\omega/2\pi \leq 7$ THz) (using $\theta = 0$, $N_{2D} = 1.0 \times 10^{12}$ cm^{-2}, $\nu = 4.0 \times 10^{13}$ s^{-1}, and $v_F = 0.829 \times 10^6$ m/s) for selected q values from 100 to 1000 cm^{-1}, with different ribbon widths: (a) $w = 155$ nm, (b) $w = 270$ nm, (c) $w = 380$ nm, and (c) $w = 480$ nm. Plasmon spectra were constructed using the Lorentz line shape function to a maximum value of 1, setting the full width at half maximum to 0.2, and the corresponding transition frequency was taken from Table 6 (in the main text) for the selected q values. A conventional exponential decay function is adopted for the dispersion of the plasmon spectra.

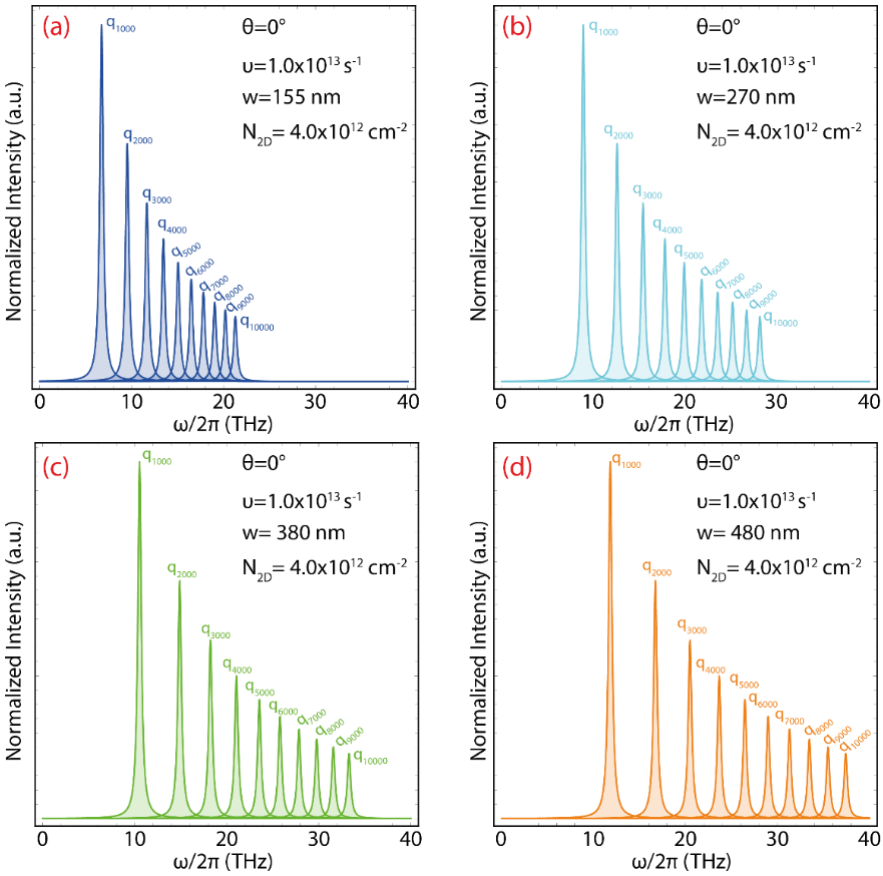

Figure S4. Plasmon frequency ($\omega/2\pi \leq 40$ THz) (using $\theta = 0$, $N_{2D} = 4.0 \times 10^{12}$ cm^{-2}, $\nu = 1.0 \times 10^{13}$ s^{-1}, and $v_F = 0.829 \times 10^6$ m/s) for selected q values from 1000 to 10,000 cm^{-1}, with different ribbon widths: (**a**) $w = 155$ nm, (**b**) $w = 270$ nm, (**c**) $w = 380$ nm, and (c) $w = 480$ nm. Plasmon spectra were constructed using the Lorentz line shape function to a maximum value of 1, setting the full width at half maximum to 0.2, and the corresponding transition frequency was taken from Table 8 (in the main text) for the selected q values. A conventional exponential decay function is adopted for the dispersion of the plasmon spectra.

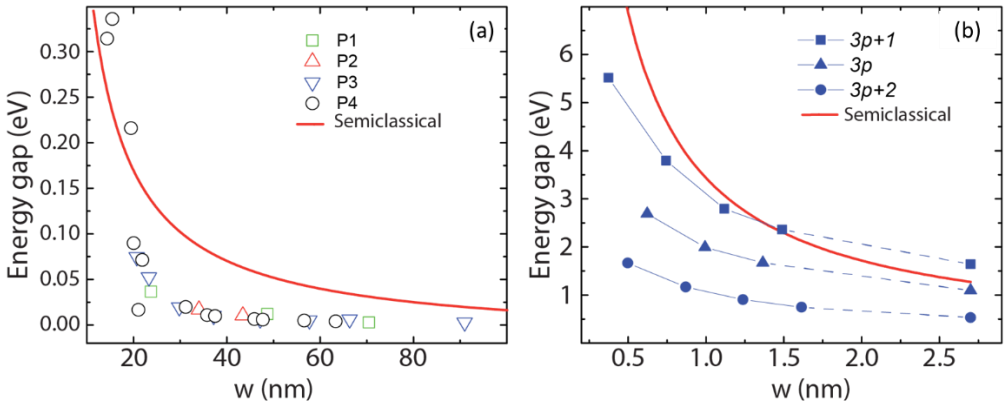

Figure S5. Bandgap as a function of ribbon width. (**a**) Experimental results for different datasets (P1-P4) and (**b**) GW approximation for different families of GNRs (Ref. [29] in the main text). The red line is the predicted curve using Equation (2) (in the main text).

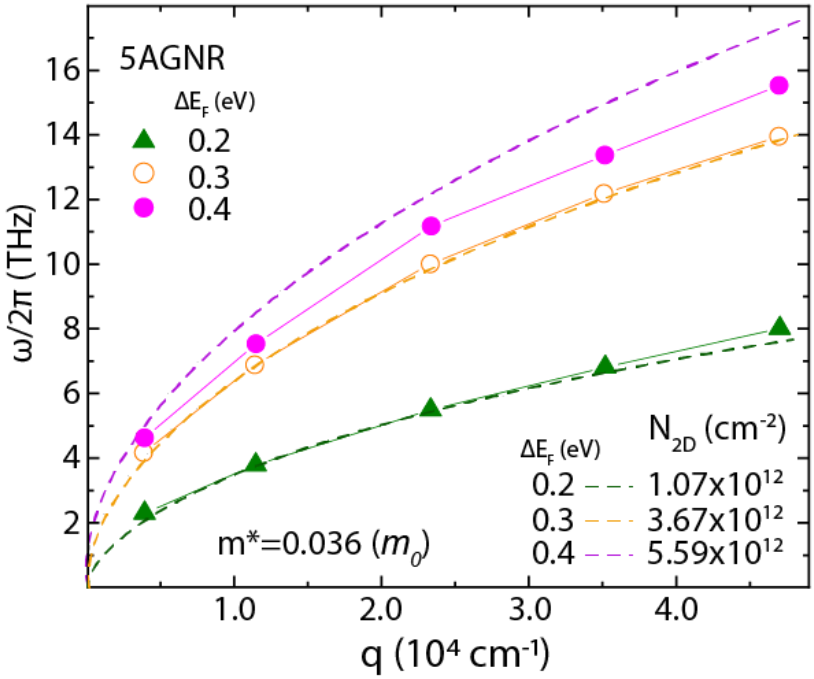

Figure S6. Plasmon frequency dispersion ($\omega/2\pi$) vs. wave vector (q) for five armchair graphene nanoribbon (5AGNR), considering the numerical TDDFT+RPA approach (Ref. [20] in the main text) and the predictions of the semi-analytical model through Equation (4). The input parameters of Equation (4) are given in the figure.