Supplementary material for:

Facile multifunctional plasmonic sunlight harvesting with tapered triangle nanopatterning of thin films

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S1. Description of the geometry

As illustrated in Figure S1b, the angle \( \theta \) is half of the opening angle of the tips of the triangles. Employing the definition of similar triangles in Euclidian geometry, we define similar concave triangles having the same tip opening angle, \( 2\theta \). It can be easily observed that keeping the ratio \( \Delta R/R_{\text{bead}} \) constant leads to a constant \( \theta \) and therefore, similar curved triangles. On the other hand, decreasing \( \Delta R \) for a given \( R_{\text{bead}} \), leads to smaller \( \theta \) values and therefore, sharper tips. Decreasing \( \Delta R \) also yields smaller \( d \) values (closer tips). In the simulations reported in Figures 2b,c the triangles are kept similar while \( R_{\text{bead}} \) is varied.

**Fig. S1 | Definition of the geometrical parameters.** (a) Top view of a unit cell of the gold front pattern. Left: schematics Right: experimental realization. Scale bar is equal to 100 nm. (b) Magnified schematics of the highlighted area in part (a) with definition and equations for the main geometrical parameters.
S2. Dip-coating Set-up

The dip-coating set-up is placed inside a closed plexiglass chamber which is equipped with humidity and temperature sensors. The humidity can be actively controlled and set to a desired value: a flow of dry nitrogen is passed through a glass bottle containing an ultrasonic vaporizer which can produce variable amounts of fine water fog.

The core of the dip-coating set-up is the linear micro stage (M-112.1DG, PI-Physik Instrumente) controlled by a DC servo motor (C-863.11, PI-Physik Instrumente). These two components ensure a smooth movement even at very low speeds, preventing disturbances of the meniscus motion due to uneven displacements.

The sample is dipped into a home-made glass well (WxH ≈ 30x6x20mm).

S3. Main works Overview

<table>
<thead>
<tr>
<th>Absorber</th>
<th>Range (Bandwidth)</th>
<th>Absorption (average)</th>
<th>Angle Insensitive</th>
<th>Polarization Insensitive</th>
<th>Overall Thickness</th>
<th>Fabrication method</th>
<th>Scalability ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossed trapezoidal arrays – Aydin et al.14</td>
<td>400-760nm (300nm)</td>
<td>&gt;50% * (71%)</td>
<td>Yes (0°-70°)</td>
<td>Yes</td>
<td>260 nm</td>
<td>E-beam lithography (top structure)</td>
<td>Poor; good if coupled with nano-imprint techniques¹</td>
</tr>
<tr>
<td>Ultra-sharp convex grooves – Sondergaard et al.19</td>
<td>450-850nm (400nm)</td>
<td>&gt;87% (96%)</td>
<td>Not Measured</td>
<td>Yes (if redeposition of gold is limited)</td>
<td>900 nm</td>
<td>FIB milling</td>
<td>Very poor²</td>
</tr>
<tr>
<td>Circularly-shaped gap plasmon resonators – Nielsen et al.15</td>
<td>400-850nm (450nm)</td>
<td>&gt;88% * (89%)</td>
<td>Yes (0°-40°)</td>
<td>Yes (very little sensitivity)</td>
<td>170 nm</td>
<td>E-beam lithography (top structure)</td>
<td>Poor; good if coupled with nano-imprint techniques¹</td>
</tr>
<tr>
<td>Nanocomposite materials – Hedayati et al.11</td>
<td>400-750nm (350nm)</td>
<td>&gt;87% * (97%)</td>
<td>Yes (0°-60°)</td>
<td>Yes (very little sensitivity)</td>
<td>145 nm</td>
<td>Sputtering</td>
<td>Very good</td>
</tr>
<tr>
<td>Tapered triangle nanopattern – Tagliabue et al.</td>
<td>380-988nm (600nm)</td>
<td>&gt;67% (88%)</td>
<td>Yes (0°-45°)</td>
<td>Yes</td>
<td>260 nm</td>
<td>NSL (top structure)</td>
<td>Good</td>
</tr>
</tbody>
</table>

(*) value estimated from the paper figures.

**Table S1: Overview of main works in the field of plasmonic broadband absorbers.** This table compares quantitatively the performances of some important designs of plasmonic broadband absorbers proposed in the literature in recent years. Reference numbers in the first column are according to the main text.
S4. Grating-coupled surface plasmon polariton (SPP)

A three layer system, air-glass-gold, can support surface plasmon polaritons (SPP) with the following dispersion relation:²

\[ e^{-4k_1^2 \frac{h_{\text{SiO}_2}}{2}} = \frac{k_1 + k_2}{k_1} \frac{k_1 + k_3}{k_1} \left( \frac{\varepsilon_1}{\varepsilon_2} \frac{\varepsilon_1}{\varepsilon_3} \right) \]

with \( k_i^2 = \beta_i^2 - k_0^2 \varepsilon_i \) for \( i = 1,2,3 \)

Materials 1,2,3 are indicated in Figure S2a, \( \beta \) is the SPP wavevector and \( k_i^* \)'s and \( \varepsilon_i^* \)'s are the vertical wavevector components and permittivities, respectively. The dispersion curve (\( \omega \) vs. \( \beta \)) is reported in Figure S2b.

The presence of a grating (in this case the array of tapered triangles) provides coupling of the normally incident light to SPP. The wavevector of the excited SPP is given by \( \beta = K_{\text{grating}} \) (see Figure S2a) which corresponds to the frequency \( \omega(\beta) \) (see Figure S2b).⁴

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**Fig. S2: SPP excitation and dispersion curve.** (a) Schematic representation of grating-coupled SPP excitation for the multilayer air-glass-gold system. In the case of normal incidence the condition \( \beta = K_{\text{grating}} \) has to be satisfied. (b) Black curve: SPP dispersion curve for the multilayer system illustrated in part (a). Blue line: air light line. Green line: glass light line. Dash-dotted vertical line: \( \beta = K_{\text{grating}} \) for the case of \( R_{\text{bead}} = 150 \) nm. The frequency \( \omega \) is the intersection of the black curve and the vertical line (red circle, \( \omega = 3.779 \times 10^{15} \) rad/s corresponding to \( \lambda = 498 \) nm).
S5. Absorption efficiency of an isolated tapered triangle on glass

We simulated an isolated tapered triangle on a glass substrate and calculated the absorption efficiency as:

\[
Q_{\text{abs}} = \frac{1}{A_{\text{triangle}}} \left( \frac{E_0^2}{2\mu_0 c} \right) \int P_{\text{dissipated}}
\]

The tapered triangle has the same dimensions as the triangles in an array with \( R_{\text{bead}} = 150 \text{ nm}, \Delta R = 2 \text{ nm} \) and \( h_{\text{AuFP}} = 100 \text{ nm} \), which has been studied in the main text.

Fig. S3: Absorption efficiency of an isolated tapered triangle. Left: Calculated absorption efficiency, \( Q_{\text{abs}} \), for an isolated tapered triangle on glass, excited with two different polarizations. The tapered triangle has the same dimensions as the triangles in an array with \( R_{\text{bead}} = 150 \text{ nm}, \Delta R = 2 \text{ nm} \) and \( h_{\text{AuFP}} = 100 \text{ nm} \). Right: 3D graphical representation of the simulated geometry.