Supporting Information for

Active tuning electromagnetically induced transparency from chalcogenide-only metasurface

Kuan Liu\textsuperscript{1,3}, Meng Lian\textsuperscript{1}, Kairong Qin\textsuperscript{1}, Shuang Zhang\textsuperscript{2} and Tun Cao\textsuperscript{1,3}

Correspondence: Tun Cao (caotun1806@dlut.edu.cn)

\textsuperscript{1} School of Optoelectronic Engineering and Instrumentation Science, Dalian University of Technology, Dalian 116024, China.
\textsuperscript{2} Department of Electrical and Electronic Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong, 999077
\textsuperscript{3} These authors contributed equally: Kuan Liu, Tun Cao

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{fig_s1.png}
\caption{The flowchart of the fabrication processing.}
\end{figure}

\begin{table}[h]
\centering
\caption{Fitting parameters}
\begin{tabular}{lcccc}
\hline
 & $\omega_E$ & $\omega_M$ & $\Pi_E$ & $\Pi_M$ & $\kappa$ \\
\hline
AD-AM & 247.8 & 214.4 & 0.4135 & 0.02985 & 0.1864 \\
CR & 169.4 & 173.5 & 0.2682 & 0.06255 & 0.1371 \\
\hline
\end{tabular}
\end{table}

In order to explore the nature of the induced modes, we perform the multipole decomposition to evaluate cartesian multipole contributions into the scattering for the single nanohole. The five multipole moments are relied on the current density ($\hat{j} = -i\omega\varepsilon_0(n^2 - 1)\hat{E}$) distribution inside the nanohole and expressed by the formula\textsuperscript{80},
\[ \vec{p} = \frac{1}{i\omega} \int \vec{j} \, d^3r \]  
(s1)

\[ \vec{M} = \frac{1}{2c} \int (\vec{\nabla} \times \vec{j}) \, d^3r \]  
(s2)

\[ \vec{T} = \frac{1}{10c} \int [(\vec{\nabla} \cdot \vec{j}) \vec{r} - 2r^2 \vec{j}] \, d^3r \]  
(s3)

\[ \vec{Q}^{(e)}_{\alpha\beta} = \frac{1}{2i\omega} \int [r_\alpha j_\beta + r_\beta j_\alpha - \frac{2}{3} (\vec{\nabla} \cdot \vec{j}) \delta_{\alpha\beta}] \, d^3r \]  
(s4)

\[ \vec{Q}^{(m)}_{\alpha\beta} = \frac{1}{3c} \int [(\vec{\nabla} \times \vec{j})_\alpha r_\beta + [(\vec{\nabla} \times \vec{j})_\beta r_\alpha] \, d^3r \]  
(s5)

where \( \omega \) is angular frequency, \( \varepsilon_0 \) the permittivity in vacuum, \( n \) the complex refractive index, \( \vec{E} \) the electric field, \( c \) the vacuum light speed. where \( \alpha, \beta, \gamma = x, y, z \).

The \( \vec{p}, \vec{M}, \vec{T}, \vec{Q}^{(e)}, \vec{Q}^{(m)} \) represent the electric dipole (ED) moment, magnetic dipole (MD) moment, toroidal dipole (TD) moment, electric quadrupole (EQ) moment, and magnetic quadrupole (MQ) moment, respectively. The scattered powers of the multipole moments can be calculated from

\[ I_P = \frac{2\omega^4}{3c^3} |\vec{P}|^2 \]  
(s6)

\[ I_M = \frac{2\omega^4}{3c^3} |\vec{M}|^2 \]  
(s7)

\[ I_T = \frac{2\omega^6}{3c^5} |\vec{T}|^2 \]  
(s8)

\[ I_{Q^{(e)}} = \frac{\omega^6}{5c^6} \sum |\vec{Q}^{(e)}_{\alpha\beta}|^2 \]  
(s9)

\[ I_{Q^{(m)}} = \frac{\omega^6}{40c^8} \sum |\vec{Q}^{(m)}_{\alpha\beta}|^2 \]  
(s10)