LIST OF FIGURES

Figure 1.1:	Interconnect architecture including local and global interconnects.	**4**
Figure 1.2:	Electromagnetic surface wave guided by the interface of two different materials.	**7**
Figure 1.3:	Highly localized field of an SPP wave.	**12**
Figure 1.4:	Geometry for SPP wave propagation.	**13**
Figure 1.5:	The dispersion diagram of the SPP wave guided by the silver/air interface. The solid line shows the real part, and the dotted line shows the imaginary part of the wavenumber *q*.	**18**
Figure 1.6:	Schematics of prism-coupled configuration to excite SPP wave (a) Turbadar-Kretschmann-Raether (b) Turbadar-Otto.	**20**
Figure 1.7:	Schematic of SPP–wave excitation in the grating-coupled configuration.	**23**
Figure 1.8:	Cartesian components of the electric and magnetic field component in the YEE cell indexed as (l, m, n).	**25**
Figure 1.9:	FDTD time-marching algorithm.	**27**
Figure 1.10:	Schematic showing the different values of correlation coefficients.	**30**
Figure 2.1:	Schematic of the computational domain of the initial boundary value problem solved for the information carried by a pulse-modulated SPP wave across a gap.	**42**
Figure 2.2:	Three snapshots of $E_z(x,z,t)$ taken at (top) $t = 46.88$ fs, (middle) $t = 103.64$ fs, and (bottom) $t = 184.16$ fs, when $\lambda_c = 600$ nm and $d = \lambda_c$. $E_z(x,z,t)$ was normalized by 0.084 V m^{-1} in the top snapshot, 0.050 V m^{-1} in the middle snapshot, and 0.039 Vm^{-1} in the bottom snapshot.	**51**
Figure 2.3:	Temporal profile of $P_x(x_R, z_R, t)$ when $\lambda_c = 600$ nm and the region $\Re_B^{right}$ is occupied by material A. (Top) $d_R = 35\lambda_c$, (middle) $d_R = 30\lambda_c$, and (bottom) $d_R = 25\lambda_c$.	**53**
Figure 2.4:	Temporal profile of $P_x(x,z,t)$ when $\lambda_c = 600$ nm and the region $\Re_B^{right}$ is occupied by material A. (Top) $d_S = 4\lambda_c$, (middle) $d_S = 20\lambda_c$, and (bottom) $d_S = 40\lambda_c$.	**54**

Figure 2.5: Pearson correlation coefficient between $P_x(x_R, z_R, t)$ and $P_x(x_S, z_S, t)$ as a function of d_{RS} when $d_R = 30\lambda_c$, $\lambda_c = 600$ nm, and the region $\Re_B^{right}$ is occupied by material A. **56**

Figure 2.6: Temporal profile of $P_x(x_R, z_R, t)$ when $d_R = 30\lambda_c$ and the region $\Re_B^{right}$ is occupied by material B. (Top) $\lambda_c = 500$ nm, (middle) $\lambda_c = 600$ nm, and (bottom) $\lambda_c = 700$ nm. **57**

Figure 2.7: Real and imaginary part of q_c versus $\lambda_c \in [400, 800]$ nm. **57**

Figure 2.8: Normalized spectra of $P_x(x_R, z_R, t)$ when $d_R = 30\lambda_c$ and the region $\Re_B^{right}$ is occupied by material B. (Top) $\lambda_c = 500$ nm (i.e., $f_c = 600$ THz), (middle) $\lambda_c = 600$ nm (i.e., $f_c = 500$ THz), and (bottom) $\lambda_c = 700$ nm (i.e., $f_c = 428.6$ THz). **59**

Figure 2.9: Temporal profile of $P_x(x_S, z_S, t)$ when $d_R / \lambda_c = 30$ and the region $\Re_B^{right}$ is occupied by material B. Top row: $d_{RS} = 35\lambda_c$, middle row: $d_{RS} = 50\lambda_c$, and bottom row: $d_{RS} = 70\lambda_c$. Left column: $\lambda_c = 500$ nm, middle column: $\lambda_c = 600$ nm, and right column: $\lambda_c = 700$ nm. **60**

Figure 2.10: Pearson correlation coefficient between $P_x(x_R, z_R, t)$ and $P_x(x_S, z_S, t)$ as a function of d_{RS} when $d_R = 30\lambda_c$, $\lambda_c \in \{500, 600, 700\}$ nm, and the region $\Re_B^{right}$ is occupied by material B. **61**

Figure 2.11: $P_x(x_S, z_S, t)$ in the time domain (top left) and frequency domain (top right), when the precursor is very close to the main pulse ($d_S = 0$). Similarly, $P_x(x_S, z_S, t)$ in the time domain (bottom left) and frequency domain (bottom right), when the precursor is widely separated from main pulse ($d_S = 49\lambda_c$) for $\lambda_c = 600$ nm. **62**

Figure 3.1: Schematic of the computational domain of the initial-boundary-value problem when the metal bends to form a corner of angle $\alpha \in (0, \pi)$. Materials A and B are dielectric and metallic, respectively. The computational domain is bounded by three perfectly matched layers. The point labeled R is identified as the transmission point, and the point S as the reception point. Point Q is chosen for analysis of the signal scattered in the region occupied by material A beyond the corner. **69**

Figure 3.2: Four snapshots of normalized $P_x(x, z, t)$ taken at (top left) $t = 4.94$ fs, (top right) $t = 17.26$ fs, (bottom left) $t = 21.96$ fs and (bottom right) $t = 37.41$ fs, when $\lambda_c = 500$ nm and $\alpha = 135^\circ$. **70**

Multiply by 1.1375×10^{-4} W m^{-2} to obtain unnormalized $P_x(x,z,t)$.

Figure 3.3: Temporal profile of normalized $P_{ax}(x_R,z_R,t)$ when $d_R=8\lambda_c$, $\lambda_c=500$ nm, and $\alpha=135^\circ$. The transmitted signal (left) and the reflected signal (right) at point R are sufficiently separated from each other in time to be distinctly identified. Multiply by 1.1375×10^{-4} W m^{-2} to obtain unnormalized $P_{ax}(x_R,z_R,t)$. **72**

Figure 3.4: Temporal profile of normalized $P_{ax}(x_R,z_R,t)$ when $d_R=8\lambda_c$, $\lambda_c=500$ nm, and $\alpha\in\{75^\circ,90^\circ,120^\circ,135^\circ,150^\circ,180^\circ\}$. Each profile is of the reflected signal at point R. Multiply by 1.1375×10^{-4} W m^{-2} to obtain unnormalized $P_{ax}(x_R,z_R,t)$. **73**

Figure 3.5: Temporal profile of normalized $P_{ax}(x_S,z_S,t)$ when $d_S=5\lambda_c$, $\lambda_c=500$ nm, and $\alpha\in\{75^\circ,90^\circ,120^\circ,135^\circ,150^\circ,180^\circ\}$. Each profile is of the received signal at point S. Multiply by 1.1375×10^{-4} W m^{-2} to obtain unnormalized $P_{ax}(x_S,z_S,t)$. **74**

Figure 3.6: Pearson correlation coefficient ρ_{RS} between $P_{ax}(x_R,z_R,t)$ and $P_{ax}(x_S,z_S,t)$ as a function of $\alpha\in[75^\circ,180^\circ]$ when $d_R=8\lambda_c$, $d_S=5\lambda_c$, and $\lambda_c=500$ nm. **76**

Figure 3.7: Real and imaginary parts of the SPP wavenumber q_c as a function of carrier wavelength λ_c. **77**

Figure 3.8: Temporal profile of normalized $P_{ax}(x_R,z_R,t)$ when $d_R=5\lambda_c$, $\lambda_c\in\{400,500,600,700\}$ nm, and $\alpha=135^\circ$. Each profile is of the transmitted signal at point R. Multiply by 1.1375×10^{-4} W m^{-2} to obtain unnormalized $P_{ax}(x_R,z_R,t)$. **77**

Figure 3.9: Temporal profile of normalized $P_{ax}(x_S,z_S,t)$ when $d_R=5\lambda_c$, $d_S=5\lambda_c$, $\lambda_c\in\{400,500,600,700\}$ nm, and $\alpha=135^\circ$. Each profile is of the received signal at point S. Multiply by 1.1375×10^{-4} W m^{-2} to obtain unnormalized $P_{ax}(x_S,z_S,t)$. **78**

Figure 3.10: Normalized peak intensity of $P_{rad}(x_Q,z_Q,t)$ as a function of $d_Q/\lambda_c\in[3,9]$ with $\lambda_c=500$ nm fixed. Left: $\alpha=90^\circ$ and $\beta\in\{0^\circ,90^\circ\}$. Right: $\alpha=135^\circ$ and $\beta\in\{0^\circ,45^\circ\}$. The peak intensity for each value of β is normalized to unity for d_Q/λ_c. The normalized curve for the $1/d_Q$ dependence is also shown. **80**

Figure 4.1: Schematic of the computational domain of the initial-boundary-value problem for information transfer by a pulse-modulated SPP wave guided by a silver/silicon interface across a wall between **87**

silicon and another material. The signal is launched on the plane $x = a$ at time $t = 0$ and the wall between silver and either (a) air or (b) silver is identified as $\{x = 0, -\infty < y < \infty, z > 0\}$. (c) Silicon continues beyond the plane $x = 0$ in the half-space $z > 0$.

Figure 4.2: Variation of the propagation distance Δ_{prop} of the carrier SPP wave with the free-space wavelength λ_c when the partnering materials are silicon and silver. **90**

Figure 4.3: Temporal profile of normalized $P_x(x_R, z_R, t)$ when $\Re_C$ is occupied by air, $\Re_D$ is occupied by silver, and $\lambda_c = 1200$ nm. Left column: $d_R = 3.5\lambda_c$, middle column: $d_R = 3.0\lambda_c$, and right column: $d_R = 2.5\lambda_c$. The top row shows the transmitted signal (red curve) at point R and the bottom row shows the tail of the transmitted signal (red curve) followed by the reflected signal (green curve) at point R. Multiply by 6.8×10^{-6} W m^{-2} to obtain unnormalized $P_x(x_R, z_R, t)$. **92**

Figure 4.4: Temporal profile of normalized $P_x(x_R, z_R, t)$ when $\lambda_c = 1200$ nm; $d_R = 3.5\lambda_c$; $\Re_C$ is occupied by (left) air, (middle) silver, and (right) silicon; and $\Re_D$ is occupied by silver. Each profile is of the tail of the transmitted signal (red curve) followed by the reflected signal (green curve) at point R. Multiply by 6.8×10^{-6} W m^{-2} to obtain unnormalized $P_x(x_R, z_R, t)$. **93**

Figure 4.5: Temporal profile of normalized $P_x(x_S, z_S, t)$ when $\lambda_c = 1200$ nm and $\Re_D$ is occupied by silver. Top row: $\Re_C$ is occupied by air, middle row: $\Re_C$ is occupied by silver, and bottom row: $\Re_C$ is occupied by silicon. Left column: $d_S / \lambda_c = 1$, middle column: $d_S / \lambda_c = 2$, and right column: $d_S / \lambda_c = 3$. Each profile is of the received signal at point S. Multiply by 6.8×10^{-6} W m^{-2} to obtain unnormalized $P_x(x_S, z_S, t)$. **95**

Figure A.1: Schematic of the PML region surrounding $\Re$. **121**