Graphene-based Unit-Cell for 1-bit Reflective Intelligent Surfaces at Microwave and mm-Wave

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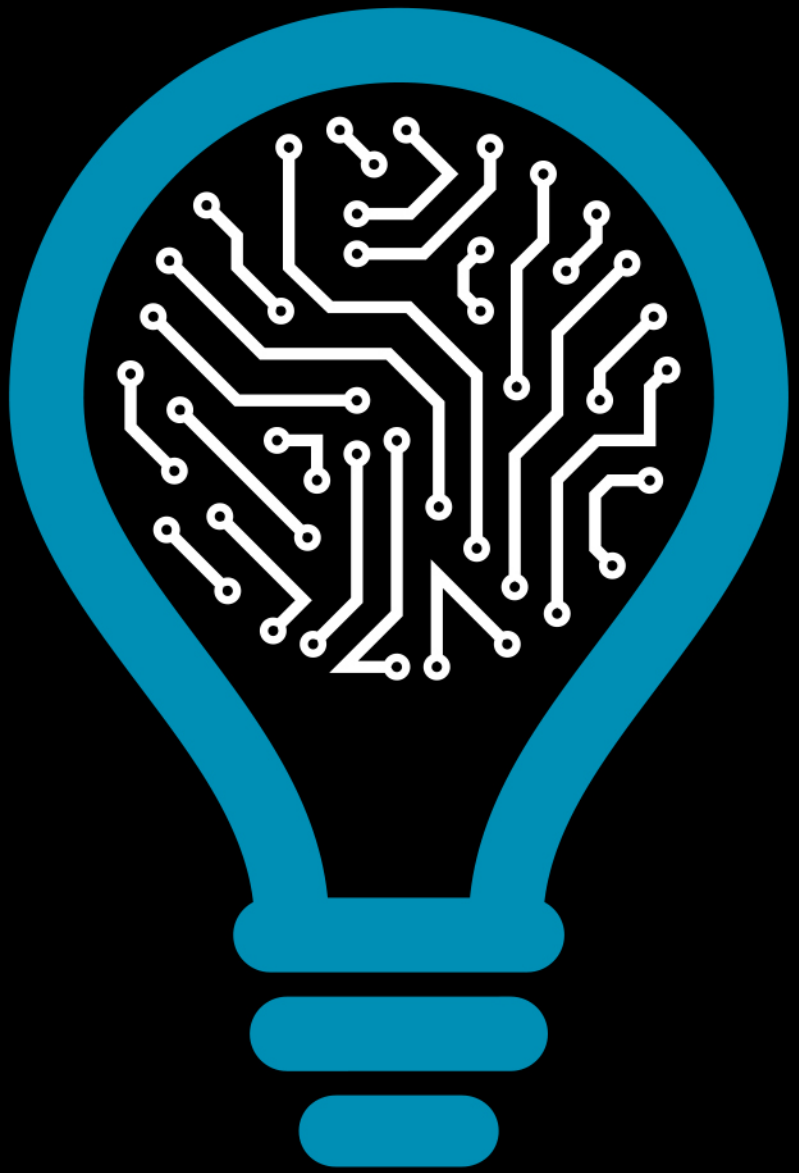

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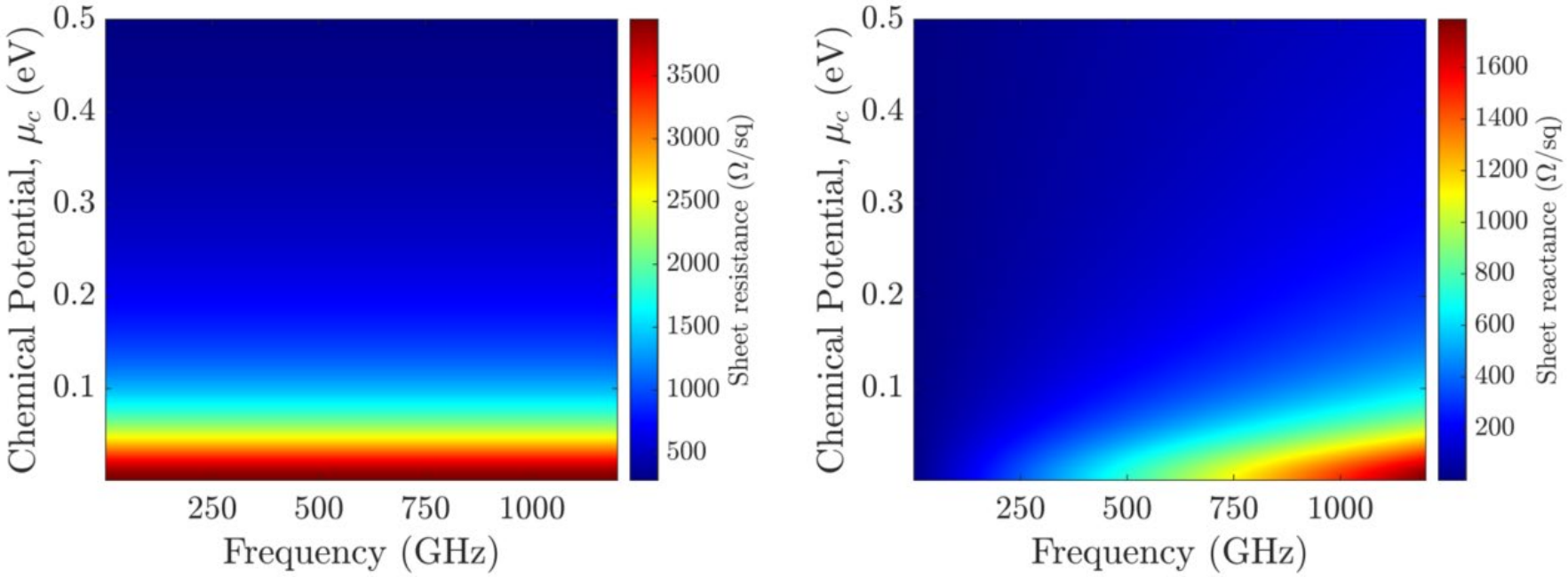
Graphene

Graphene is a two-dimensional material composed of carbon atoms arranged in a honeycomb lattice structure.

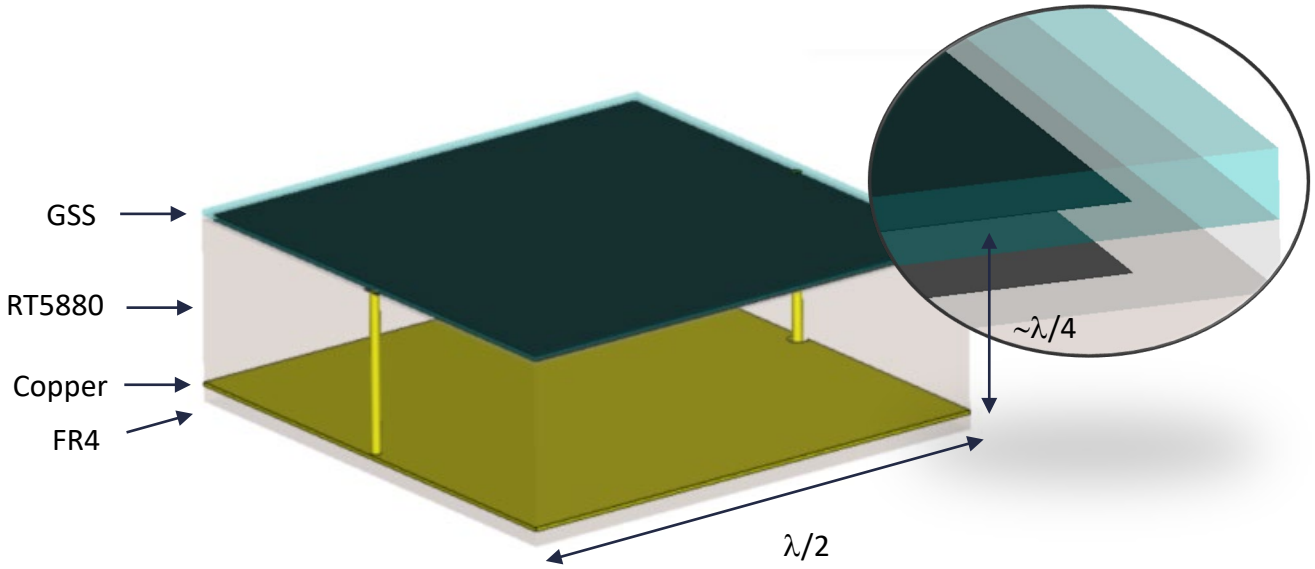
Graphene's complex conductivity is expressed as Kubo's formula as:

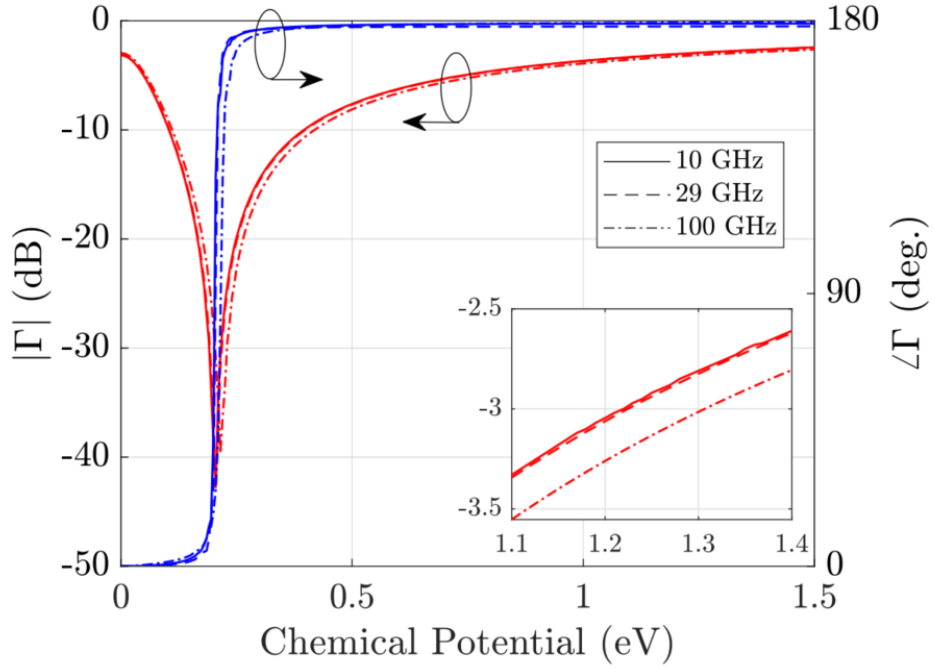
$$\sigma(\omega) = -\frac{jq^2 k_B T}{\pi\hbar^2(\omega - j2/\tau)}\left(\frac{\mu_c}{k_B T} + 2\ln\left(e^{-\frac{\mu_c}{k_B T}} + 1\right)\right)$$



Principle of Operation of Unit-cell

The proposed graphene-based unit-cell design:

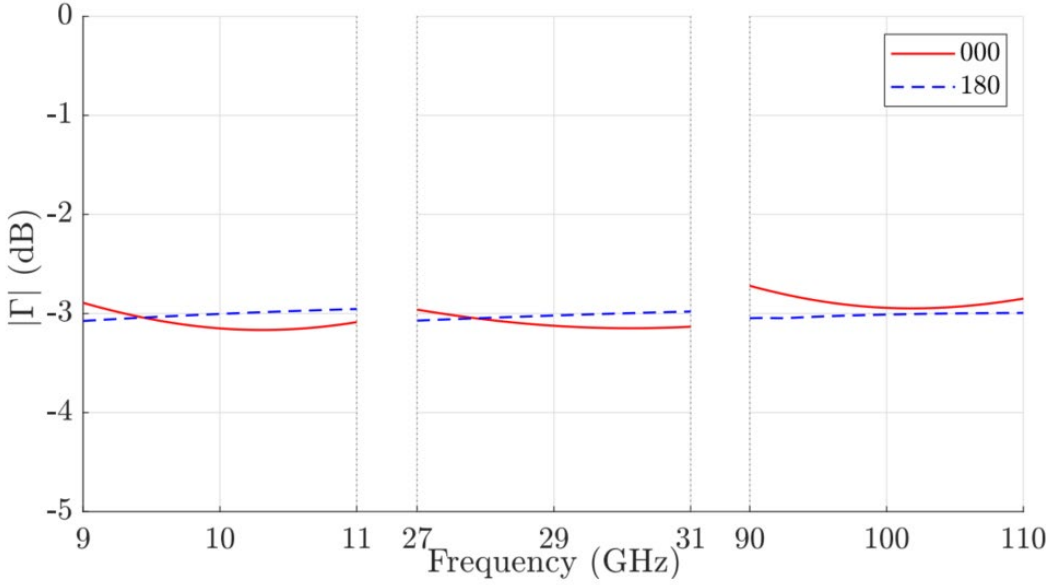


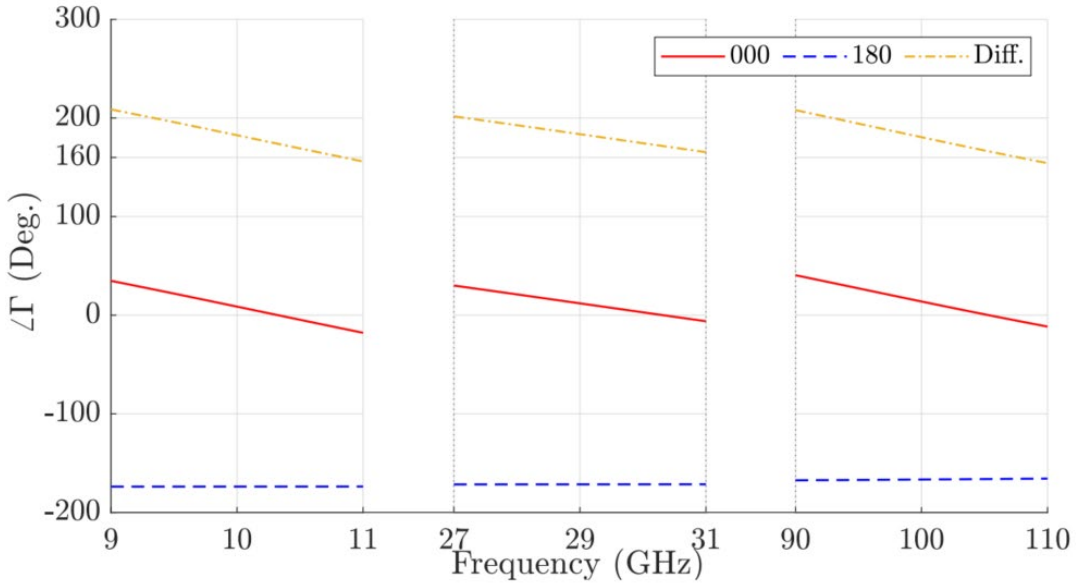


Simulation of the unit-cell

Reflection coefficient for:

- 10 GHz (h = 4.8 mm);
- 29 GHz (h = 1.575 mm);
- 100 GHz (h = 0.39 mm).





Graphene-based Reflectarray

The presented 1-bit graphene-based unit-cells can be used to implement a beam-steering reflectarray for diverse scan angles.

Antenna Parameter	X Band	Ka Band	W Band
Aperture size (mm)	480×480	165.5×165.5	48×48
Number of elements	$32 \times 32 = 1024$		
Focal Distance (mm)	384	128	38.4
Polarization	Linear		
Element's spacing	$\lambda/2$		
Operating frequency range (GHz)	9.3-10.8	27-31	92.9-107.7
Scan angle	$\pm 60°$