Optically Transparent Microwave Devices for Telecommunications Based on Engineered Graphene

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We will report on radiation elements, operating over a wide microwave operating bandwidth (> 3.5 GHz) simultaneously covering the WiFi, Bluetooth and 5G bands, that exploit highly conductive Chemical Vapour Deposition graphene [1-2]. In particular, the design of a wide planar CVD graphene-based antennas will be detailed.
At microwave frequencies (e.g. L, S or X microwave bands) monolayer graphene thickness, equal to 0.34 nm, corresponds to about $\lambda/10^6$. Thus, monolayer or few-layer graphene act as a real "sheet current" with a finite conductivity.
A 3D numerical model in Comsol Multi-Physics is developed where graphene is modelled as a sheet current ($J=\sigma*E$) with a finite conductivity σ (where σ is equal to $1/Rs$)
We demonstrate that CVD graphene can successfully exploited for the realization of flexible and optically transparent antennas (transmittance of about 85%). The -10dB bandwidth is wide enough to cover the several microwave frequency ranges.
Another important feature offered by graphene antennas is related to the tunability of graphene transport properties, i.e. the "ambipolar effect". This last feature could open the way to realize tunable antenna arrays for beam-steering (or beam-forming) applications. The combination of all the CVD graphene properties (transparency, flexibility and tunability) could be strategic for the integration of graphene antennas in photovoltaics, security, military and healthcare applications systems.

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References

[1] M. Grande, G. V. Bianco et al., Scientific Reports, **5** (2015) 17083.
[2] M. Grande, G. V. Bianco et al., Optics Express, **24** (2016) 22788-22795.

Figures

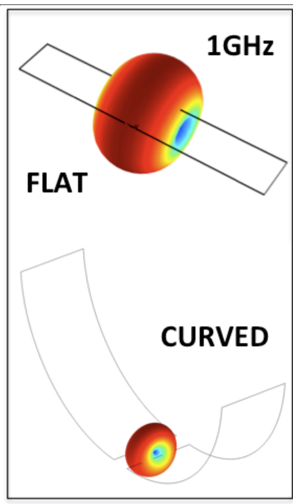

Figure 1: Comparison between the radiation patterns of a (top) "flat" and (bottom) "flexible" graphene-based antenna with the central feeding scheme at 1 GHz. The color corresponds to the gain.