Tunable Resonance of Star Shaped Nanostructures

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Introduction: Auto assembled Ag-ZnO [1] star shaped nanostructures depicted in figure 1, presents their natural electromagnetic resonance at 60 THz [2] being possible changing this value by covering it with a variable in thickness layer of gold.

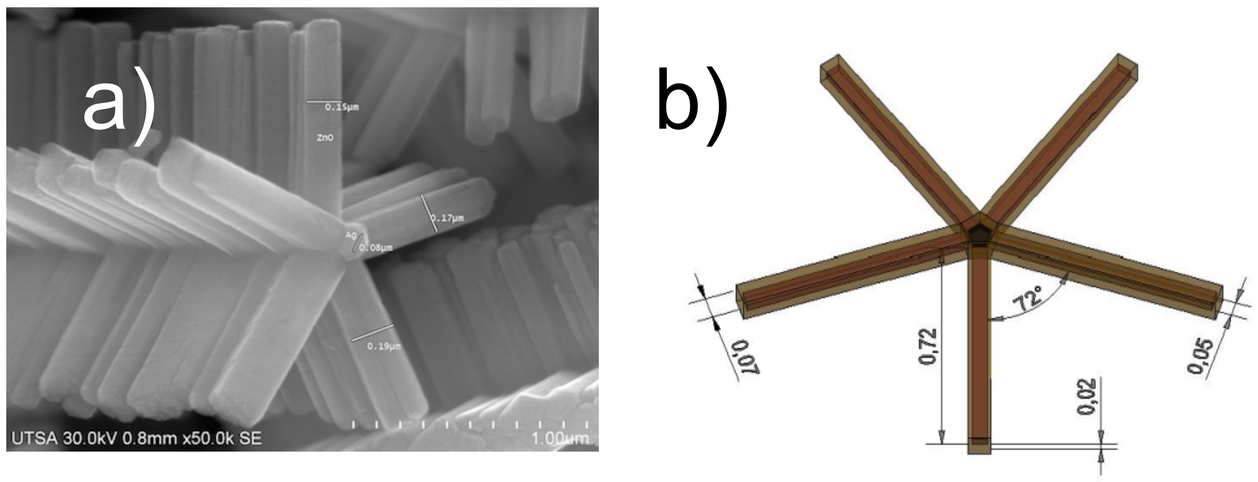


Figure 1. Star shaped nanostructure. a) Actual SEM image. b) COMSOL simplified geometry representation.

Computational Methods: Using the RF module [3] to solve equation 1, and applying a planar electromagnetic wave, we can find the interaction of electromagnetic field over the structure for different thickness layer of gold.

$$\nabla \times \left(\nabla \times E \right) - k_0^2 \varepsilon_r E = 0 \qquad (1)$$

For each different thickness, must be necessary find their respective frequency of resonance. For a particular case of a 50 nm of thickness, figure 2(a) depicts the electromagnetic field intensity response, and figure 2(b) depicts the shape and intensities in their resonance frequency.

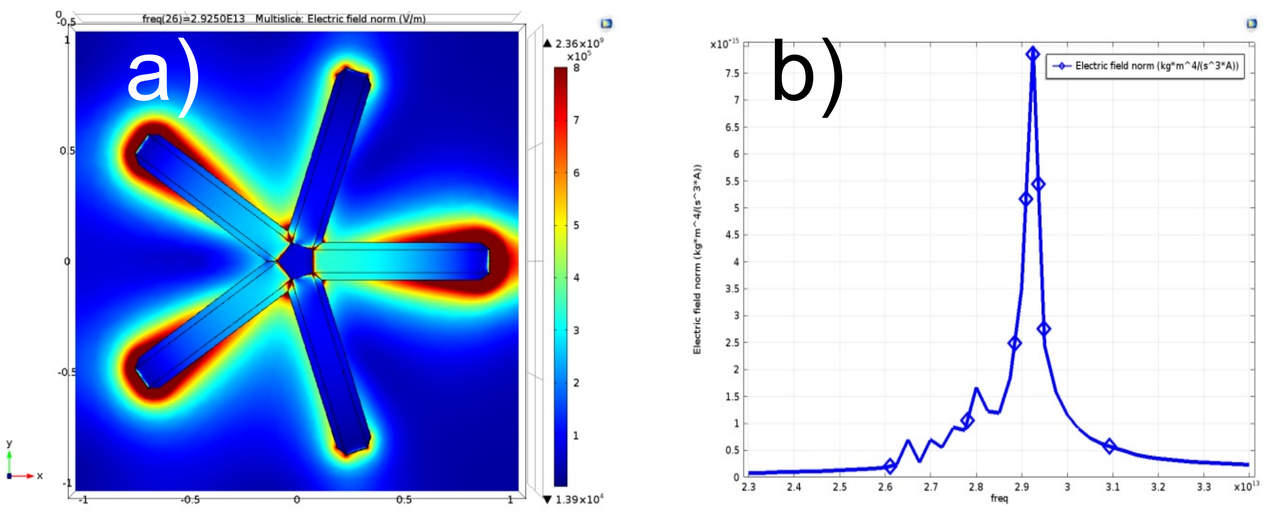


Figure 2. a) Freq. vs. electromagnetic field. b) Simulated electromagnetic field @ resonance freq. (30 THz).

Results: It is possible to have control about the resonance frequency over the star shaped Ag-ZnO nanostructures by covering them with a layer of gold. The resonance frequency is a function of the layer thickness as can be seen in figure 3. Figure 4 depicts a linear fited curve from results.

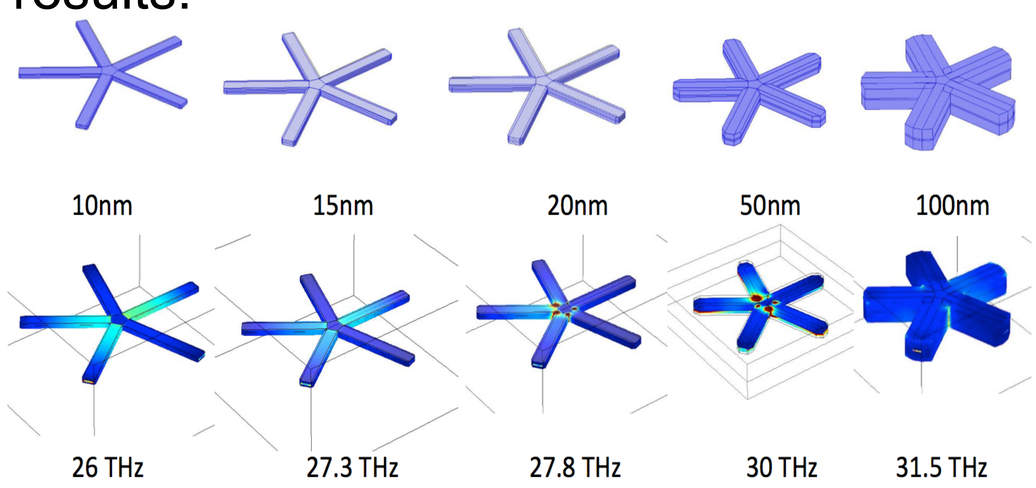
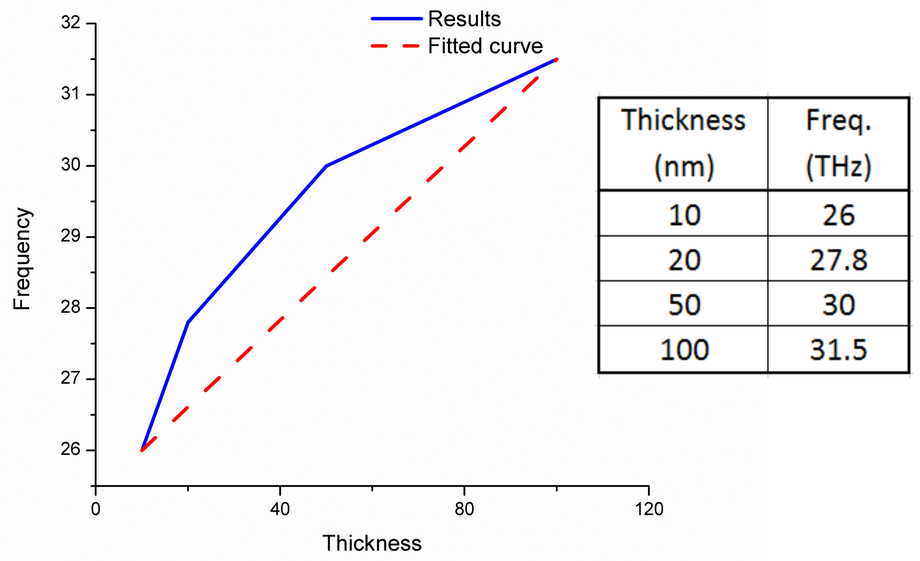


Figure 3. Relation between gold layer thickness and their respective resonant frequency.



Thickness (nm)	Freq. (THz)
10	26
20	27.8
50	30
100	31.5

Figure 4. Results and linear fitted curve from results.

Conclusions: Adding a layer of gold allows the control of resonance frequency of star shaped Ag-ZnO nanostructures which can be used as THz radiation detection and/or as nanoantennas for TB/s communications which is the next step on this research.

References:

1. J. E. Sanchez et al, Electric radiation mapping of silver/zinc oxide nanoantennas by using electron holography, JOURNAL OF APPLIED PHYSICS 117, 034306 (2015).
2. J. E. Sanchez et al, Resonance properties of Ag-ZnO nanostructures at terahertz frequencies, OPTICS EXPRESS, 23, 025111, (2015).
3. COMSOL Multiphysics, RF Module manual, (2016).