# Perfect Matching of Experimental and Simulated Optical Responses of Metallic Nanostructures Obtained Through the Use of Correct Refractive Index

J. Laukkanen, A. Lehmuskero, J. Turunen
*Department of Physics and Mathematics, University of Eastern Finland, Joensuu, FI-80101, Finland*
*Janne.laukkanen@uef.fi*

B. Bai
*State Key Laboratory of Precision Measurement Technology and Instruments, Department of Precision Instruments, Tsinghua University, Beijing 100084, China*
*Tsinghua-Foxconn Nanotechnology Research Center, Tsinghua University, Beijing 100084, China*

In our recent studies we have found that the most influential factor in the matching of the experimental and simulated responses of metallic nanostructures is the use of correct refractive index.[1,2] Commonly the presented experimental and simulated results do not match and the difference is sometimes quite significant. In most cases the authors explain this through slight differences between fabricated structures and original designs.

We have defined refractive indexes by ellipsometry from thin films deposited with the same technique as the metal layers for lift-off. Previously it has been found that the refractive index of a thin film differs a lot from literature values for bulk materials.[3] Refractive index of a thin film depends on the used deposition technique and on the thickness of the film. Each deposition technique and system produces characteristic surface roughness, porosity and purity. When refractive index obtained from a thin film with similar thickness and made with same deposition system is used in simulation, all these factors are automatically taken into account.

We have studied the gold grid structure shown in figure 1. Period of the structure was 800 nm, hole width 375 nm and height 65 nm. In figure 2 the refractive indexes of bulk gold and a thin film are shown. Measured transmittances for *s*- and *p*-polarizations are shown as well as simulated transmittances calculated using refractive index of bulk gold[4] and measured refractive index of a thin film are shown in figure 3.

---

[1] B. Bai, J. Laukkanen, A. Lehmuskero, and J. Turunen, Phys. Rev. B **81**, 115424 (2010).
[2] B. Bai, J. Laukkanen, A. Lehmuskero, X. Li, and J. Turunen, Phys. Rev. B **81**, 235423(2010).
[3] A. Lehmuskero, M. Kuittinen, and P. Vahimaa, Opt. Express **15**, 10744–10752 (2007).
[4] *CRC Handbook of Chemistry and Physics*, 64th ed., (CRC Press, Boca Raton, 1984).

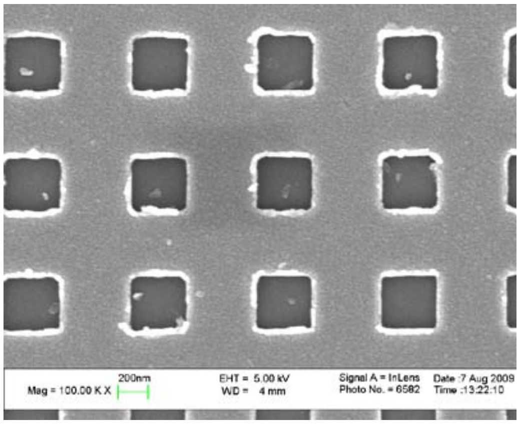


*Figure 1:* Studied gold grid structure. Period of the structure was 800 nm, hole width 375 nm and height 65 nm.

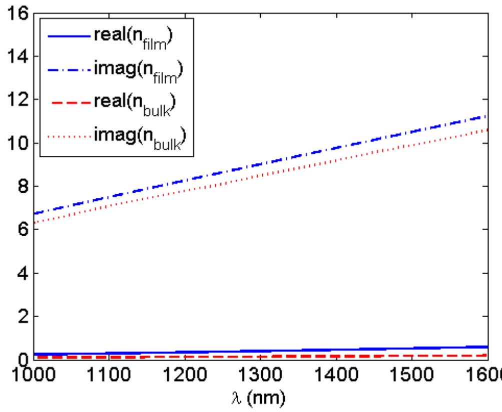


*Figure 2:* Real and imaginary parts of refractive index of gold obtained from a thin film (film) and literature (bulk).

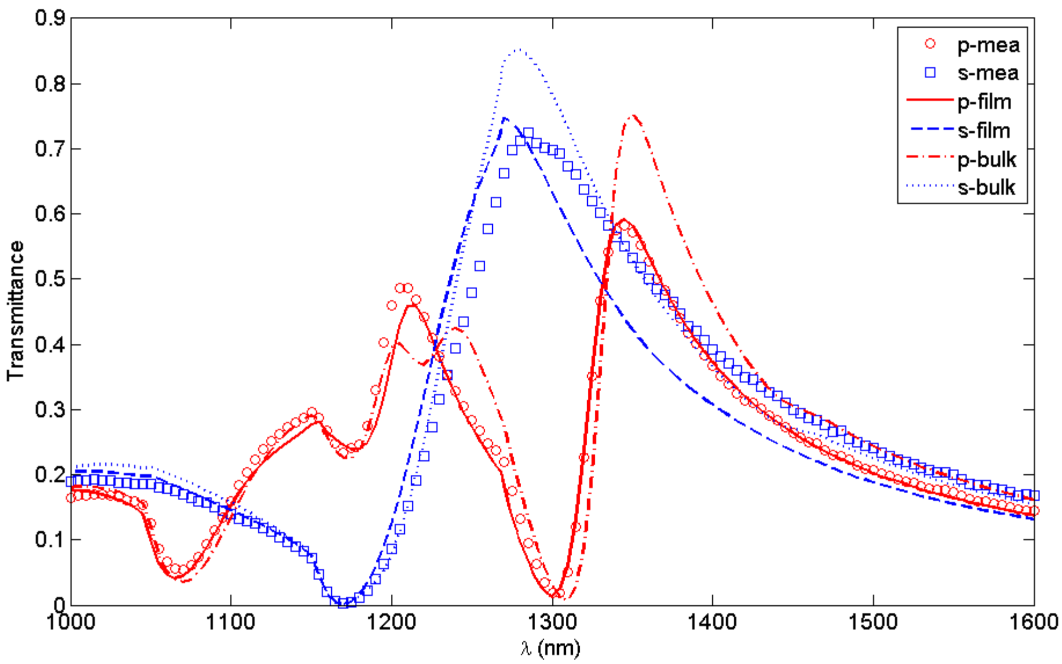


Figure 3: Measured transmittances for *p*- and *s*-polarizations and simulated transmittances calculated using refractive index of bulk gold and measured refractive index of a thin film.