Supporting Information for

Electron-Phonon Scattering in 2D Silver Nano-Triangles

Benoît Dacosta Fernandes, [†] *Aurélie Le Beulze,* [‡] *Fabien Moroté,* [†] *Jean Oberlé,* [†] *Mona Tréguer-Delapierre,* [‡] *Julien Burgin,* [†] *and Pierre Langot* [†,] *

[†]Univ. Bordeaux, LOMA, 351 cours de la Libération, 33 400 Talence, France

[‡]CNRS, Univ. Bordeaux, ICMCB, 87 Avenue du Dr. Albert Schweitzer, 33 600 Pessac, France

Finite Element Analysis and particle thickness determination

We perform finite element analysis using COMSOL software: Solid mechanics module, Eigen frequency solver. We compute the vibration Eigen modes frequencies of 3D solids or we use the 2D axisymmetry mode to reduce the computation time if possible. We use the elastic constants of bulk polycrystalline silver (E = 83 GPa, υ = 0.36 and ρ = 10 490 kg.m^{-3}).

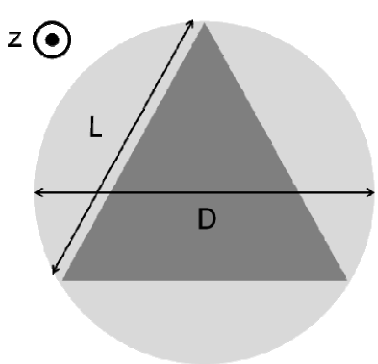

Figure 1. Top view of a prism and its circumscribed disk. We consider the diameter of the circle $D = \sqrt{3}L/_2$ as the characteristic length.

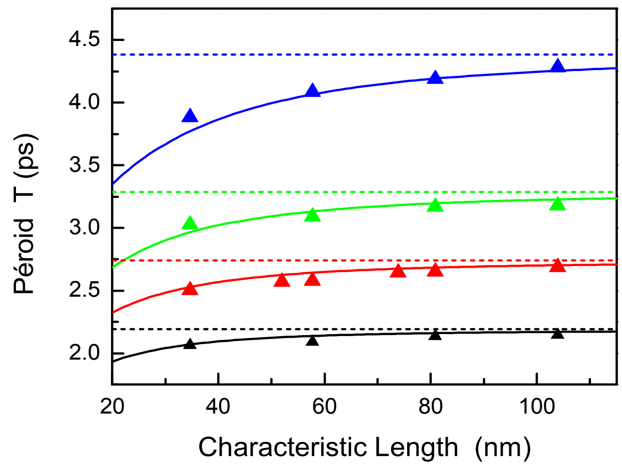

Figure 2. Calculated periods of the thickness mode of cylinders (lines) and prisms (triangles) of several thicknesses as a function of their characteristic length (lines). The color code is the following: the thickness of 4, 5, 6 and 8 nm correspond to the black, red, green and blue items respectively. The dotted lines correspond to the thickness mode of an infinite thin film.

We compute the vibrational modes of triangular 3D nanoprisms of several length and thickness. We find that the fundamental extensional modes and its harmonics present long periods (T > 20 ps) compared to the electron phonon coupling times and are not observed on our experimental data.[1,2] Looking for higher frequency modes, we find the thickness mode at 312 GHz (3.2 ps) for a thickness H = 6 nm and length L = 70 nm ($D \approx$ 81 nm). This mode is called thickness mode because its displacement field is mostly along the z axis. It is similar to the thickness mode observed in thin metal films which period is given by $T_{film} = 2H/_{c_L}$, where H is the film thickness and c_L is the longitudinal sound velocity.[1,2] Figure 2 shows the computed period of the thickness as a function of the characteristic length of the prisms (*i.e.* the diameter of their circumscribed circle, Fig. 1) for several thicknesses. We compare this result to the periods calculated in thin films of the same thickness (dotted lines). We clearly see an asymptotic behaviour for large prisms. This result is in agreement with measurement performed by Fedou *et al*: the thickness mode is not strongly affected by the shape of the particles.[3] These calculations performed in 3D geometry can present difficulties since the prismatic shape present sharp apexes. To circumvent this problem and reduce the computing time, we compute the period of the thickness mode for cylinders having the same thickness. The results are shown in Figure 2, and we see that for a sufficient length over thickness ratio, they are very close to prisms' periods. These calculations are easier and faster to perform because they are done in 2D, using the axisymmetry mode. We can perform a nondimensionalization plotting $^{T}/_{T_{film}}$ as a function of $^{D}/_{H}$. The result is shown in Figure 3a. We fit the nondimensioned data with the following *ad-hoc* function $f(x) = a + \frac{b}{(1+cx)^d}$ in order to create an abacus plot of the thickness mode period as a function of the thickness *H*, for several diameters (ranging from 25 to 80 nm here). The abacus is shown in Figure 3b. Finally, we determine the thickness of every sample from this figure. Indeed, starting from the measured period of the thickness mode and from the TEM measured length, we determine the thickness of every sample unambiguously.

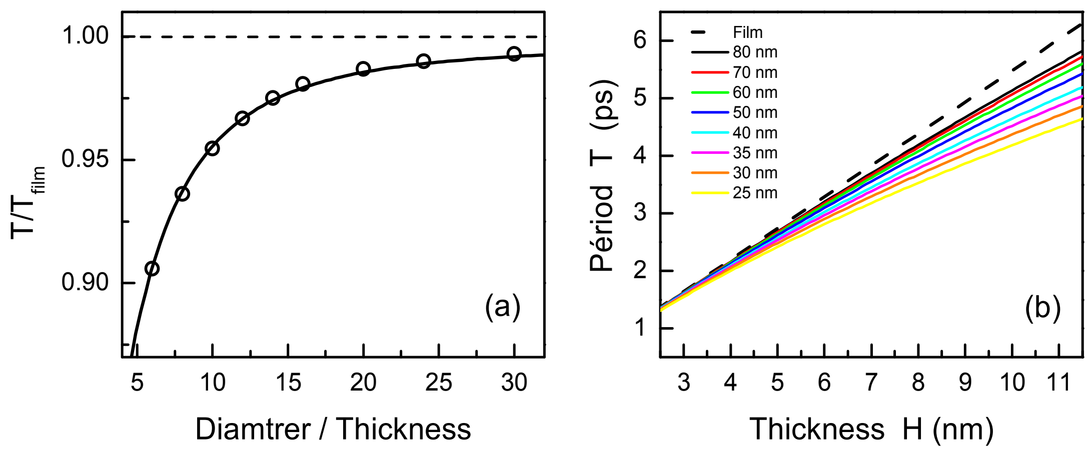

Figure 3. (a) Calculated periods of the thickness mode for cylinders (normalized on the film thickness mode period T_{film}) as a function of the diameter to thickness ratio (dots) and fit using an *ad-hoc* function (line). (b) Periods of the thickness mode for cylinders as a function of their thickness for several diameters (ranging from 25 to 80 nm). The dotted line corresponds to the thickness mode period of an infinite thin film.

References

[1] Del Fatti, N.; Voisin, C.; Christofilos, D.; Vallée, F.; Flytzanis, C.; Acoustic Vibration of Metal Films and Nanoparticles. *J. Phys. Chem. A* **2000**, *104*, 4321-4326.

[2] Burgin, J.; Langot, P.; Del Fatti, N.; Vallée, F.; Huang, W.; El-Sayed, M. A.; Time-Resolved Investigation of the Acoustic Vibration of a Single Gold Nanoprism Pair. *J. Phys. Chem. C.* **2008**, *112*, 11231-11235

[3] Fedou, J.; Viarbitskaya, S.; Marty, R.; Sharma, J.; Paillard, V.; Dujardin, E.; Arbouet, A.; From Patterned Optical Near-Fields to High Symmetry Acoustic Vibrations in Gold Crystalline Platelets. *Phys. Chem. Chem. Phys.* **2013**, *15*, 4205-4213.