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"Use of ultrashort laser pulses to modify plasmonic nanostructures"

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RESUMEN

The optical response of plasmonic nanoparticles can be engineered for an incredibly large number of useful applications. However, it requires a complex balance between the competing requirements of the application, optics, and fabrication. Hence, a compromise must be reached in most cases, which implies using nanoparticles with a sub-optimal optical response for the specific application. This highlights the need to develop new manufacturing or modification strategies to have a better control over the nanoparticles' optical response. Femtosecond laser irradiation can provide the required flexibility to attain an extreme control over the modification of various types of plasmonic nanoparticles, producing structures with a greatly improved optical response. For example, we have devised a light-controlled synthetic procedure that allows the fabrication of selected plasmonic oligomers [1]. This process can be tuned to increase the temperature at the interparticle gaps to melt tips and weld the particles together, offering a new pathway toward the fabrication of novel complex nanoparticles with a plasmonic response not attainable by other methods. We have also demonstrated that irradiation of nanorod colloids with a femtosecond laser can be tuned to induce controlled reshaping, yielding colloids with unprecedentedly narrow localized surface plasmon resonance bands [2]. The process is characterized by a gentle multi-shot reduction of the aspect ratio, responsible for the widening of the plasmon band, whereas the rod shape and volume are barely affected. This perfection process provides a simple, fast, reproducible, and scalable route toward nanorods with an optical response of exceptional quality, near the theoretical limit. Finally, we will also discuss how we can use the irradiation with laser pulses to fabricate hollow nanoparticles. On one hand, we suggest an efficient method to produce hollow nanoparticles under certain specific conditions [3]. On the other hand, we also discuss how the irradiation of spherical nanoparticles with nanosecond laser pulses induces shape transformations yielding nanocrystals with an inner cavity [4]. The concentration of the stabilizing surfactant, the use of moderate pulse fluences, and the size of the irradiated particles determine the efficiency of the process and the nature of the void.

References

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Viernes 3 de junio de 2022, 13:00 h