Controlled fragmentation of quasi-infinite particle chains into oligomeric subchains under the influence of external strain

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Among the different plasmonically active assemblies, linear chains of nanoparticles are of special interest. These plasmonic polymers can provide directional, plasmonic waveguiding properties, as well as polarization-dependent field enhancement. An essential parameter governing many optical effects is the number of particles (n) forming a chain. Above the so called infinite chain limit, n_{inf} [1], the n dependence of plasmonic properties is limited; however, shorter chains below n_{inf} (i.e., plasmonic oligomers) are highly responsive to variations in n. Therefore, controlling n below the infinite chain limit is an active topic in nanophotonics.

We present a scalable approach towards the formation of oriented chains consisting of a few to many plasmonic nanoparticles according to the described plasmonic oligomers or polymers ($n > n_{inf}$). Transferring these different sized chains onto a TEM grid allows a detailed investigation of the plasmon resonance by comprehensive spatially resolved electron energy loss studies. Here, we will particularly address the transition from individual single particle modes to plasmonic bands in quasi-infinite long chains, which has not been directly observed previously.[2]

In addition, we present a scalable approach to produce targeted particle oligomers. These plasmonic oligomers are formed by first assembling quasi- infinite chains above the infinite chain limit and subsequently fragmenting them using mechanical deformation of the underlying elastomeric substrate. Furthermore, we also demonstrated that the resulting mean chain length can be tuned depending on the ratio of cohesion between the particles and adhesion of the colloids to the supporting elastomeric substrate. [3]

Within this work we demonstrate, that mechanical stimulus is a powerful tool for the scalable fabrication of oriented linear plasmonic oligomers and opens new avenues for strain-dependent optical devises and mechanoplasmonic applications. An example is surface-enhanced sensing, where the reversible switching of the nanostructure may be utilized to trap/infiltrate target molecules into uniform hot-spots

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