Plasmonic Resonances: From 1D Atomic Chains to 3D Atomic Cuboids

(5 Aug 2016)

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The collective electronic excitation in 2D rectangular planes and 3D cuboids has been studied by real-time time-dependent local density approximation calculations. We investigate how the plasmon modes evolve from 1D systems into 2D systems, and then evolve into three dimensional (3D) systems using the time-evolution method. To understand the evolution of plasmon modes from 1D systems into 2D systems, we investigate the plasmon mode behavior in coupled chains in which the system consists of two sodium atomic chains. We then increase the number of coupled chains that participate in coupling to study the plasmonic properties due to the coupling effect. Next we study the plasmonic properties in sodium rectangular atomic planes by changing the length and width of the planes. To understand the evolution of plasmon modes from 2D systems into 3D systems, we construct a system consisting of two atomic planes to investigate plasmonic properties in this coupled plane system. We then increase the number of planes that participate in coupling to study the plasmonic properties due to the coupling effect. After that, we study the plasmon mode behavior in cubes by changing the size. Finally, we study the plasmonic properties of rectangular cuboids by changing the height of the cuboids. The size-dependent plasmon mode behaviors of 2D planes and 3D cuboids can be explained using a simple dipole-dipole interaction model.