

Photo-induced ultrafast melting in plasmonic nanoparticles observed via single-pulse time-resolved imaging using XFEL

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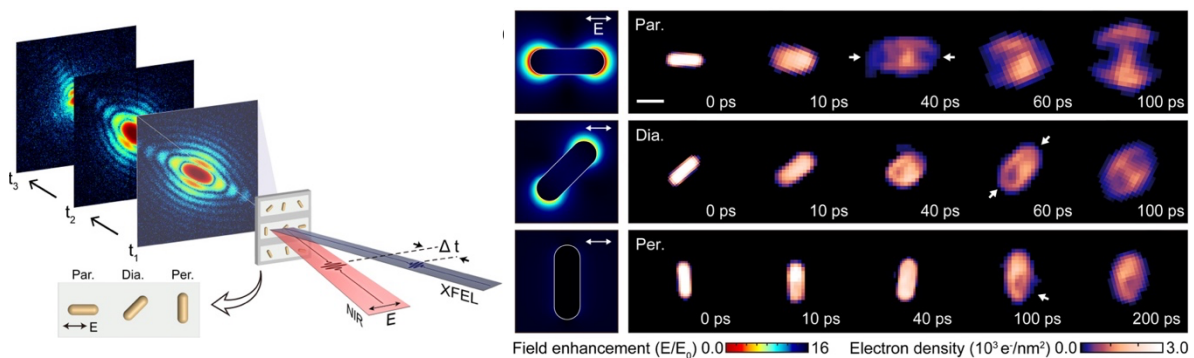
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Photoinduced ultrafast phenomena manifest the emergence of exotic phases beyond thermodynamic limits, opening new opportunity for the light control of materials energetics[1-2]. Despite extensive research, the ability to manipulate materials' energy relaxation paths remains poor caused by lack of clear evidence demonstrating the active control of phase-changing kinetics through light-matter interactions. We leveraged single-pulse time-resolved X-ray imaging of Au nanorods to showcase control over the solid-to-liquid transition by photoinduced localized surface plasmons. Our study on Au nanorods uncovers transverse or longitudinal melting modes accompanied by characteristic plasmon-induced oscillatory distortions at different laser fluences. Numerical simulations confirm that localized surface plasmons dictate ultrafast energy relaxation process from photoexcited hot electrons to anharmonic nanocrystal deformations. Direct evidence of photoinduced surface plasmon-mediated ultrafast control of materials energetics at nanoscale is provided to establish a foundation for customizing nanoscale energy transfer processes using femtosecond laser fields. Furthermore, we introduce investigations on other plasmonic nanoparticles, such as Au nanotriangles and chiral Au helicoid nanoparticles, to explore how symmetry and chirality in structure affect the role of surface plasmons in mediating the energy relaxation process during photoinduced ultrafast melting.



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References:

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