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EDITORIAL

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Ultrahigh Fields in Ultrasmall Spaces

The high electric fields created at the surfaces of metal nanoparticles, or in junctions between particles, are at the heart of surface-enhanced spectroscopies, such as surface-enhanced Raman spectroscopy (SERS).[1,2] The development of new strategies to create these high fields is an extremely active area of research in Physical Chemistry, with many different approaches being explored, such as synthesizing particles with novel shapes,[3] creating cavities in thin metal films,[4] and assembling arrays of metal nanoparticles.[5] The applications for these materials include label-free imaging and sensing in biological systems,[6] as well as spatially controlling photochemical reactions.[7,8]

There are many challenges in this field, and an obvious one is rationally designing the materials. In the Perspective by Álvarez-Puebla, Liz-Marzán, and García de Abajo, the conditions necessary to achieve high electric fields in metal nanostructures are explored.[9] The authors concentrate on how geometry, the material properties of the particles, and non-local effects modify the near-field optical response of metal nanostructures. In particular, they show that gaps between metal particles and particles with sharp features are extremely effective at confining light to small volumes,[9] which is crucial for surface-enhanced spectroscopies.[1,2,10]

The Perspective by Nabika and Murakoshi provides a comprehensive review of top-down and bottom-up approaches to creating nanostructures for enhancing photoenergy conversion processes.[11] The authors discuss how surface-enhanced spectroscopies and particle trapping experiments can be used to probe the fields around nanostructures. They also present recent advances in using metal nanostructures for enhancing photochemical reactions[7,8] and improving the performance of photovoltaic cells.[12]

The results discussed in these Perspectives provide a guide to researchers for designing metal nanostructrures for surface-enhanced spectroscopy, imaging and photochemistry, and choosing the theoretical and experimental tools necessary to analyze the field distributions in these structures. This holistic approach is vital for moving this field forward.

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