Surface Molecular Analysis at the Nanoscale using Tip-Enhanced Raman Spectroscopy

Naresh Kumar

ETH Zurich, Vladimir-Prelog-Weg 3, 8093 Zurich, Switzerland
kumar@org.chem.ethz.ch

Label-free and non-destructive surface molecular analysis at the nanoscale under ambient conditions is essential in several areas of chemical, material and biological sciences including heterogenous catalysis, biomembranes, polymeric materials etc. However, conventional analytical techniques often lack the required sensitivity and/or spatial resolution to achieve this goal. In this talk, I will introduce a rather recent nanoanalytical technique called tip-enhanced Raman spectroscopy (TERS), which combines the molecular specificity and sensitivity of surface-enhanced Raman spectroscopy (SERS) and high spatial resolution of scanning probe microscopy (SPM) to provide correlative topographical and chemical surface characterization at the nanometer length-scales [1]. I will first present an overview of the fundamental principle of TERS and then demonstrate its application with the following three studies recently published by our laboratory:

1. Nanoscale Chemical Imaging of Supported Lipid Monolayers using TERS [2]
2. Molecular-Level Insights on Reactive Arrangement in On-Surface Photocatalytic Coupling Reactions Using TERS [3]
3. Visualizing Surface Phase Separation in PS-PMMA Polymer Blends at the Nanoscale [4]

Through these studies, I will show that TERS can provide unique molecular information which cannot be obtained by any other nanoanalytical techniques.

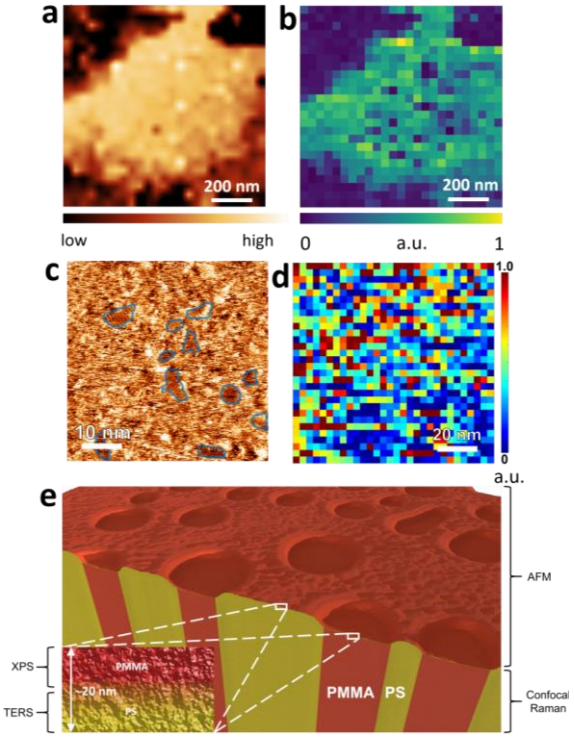

Figure 1. (a) STM topogrphy and (b) TERS images of a DPPC lipid monolayer on Au(111) surface [2]. (c) High-resolution STM topogrphy and (d) TERS images of 4NTP→DMAB photocatalytic conversion on Au(111) surface [3]. (e) Schematic illustration of the 3D structure of phase separation at PS-PMMA polymer blend surface determined using combined AFM, confocal Raman, XPS and TERS measurements [4].

References:

[1] D. Mrđenović, Z.-F. Cai, Y. Pandey, G. L. Bartolomeo, R. Zenobi, N. Kumar, *Nanoscale*, **2023**, *15*, 963-974.
[2] Y. Pandey, N. Kumar, G. Goubert, R. Zenobi, *Angew. Chem. Int. Ed.*, **2021**, *133*, 19189-19194.
[3] Z.-F. Cai, J. P. Merino, W. Fang, N. Kumar, J. O. Richardson, S. D. Feyter, R. Zenobi, *J. Am. Chem. Soc.*, **2022**, *144*, 538-546.
[4] D. Mrđenović, D. Abbott, V. Mougel, W. Su, N. Kumar, R. Zenobi, *ACS Appl. Mater. Interfaces*, **2022**, 14, 24938–24945