A vacuum-ultraviolet laser with submicrometer spot for spatially resolved photoemission spectroscopy

The rapid development of two-dimensional quantum materials, such as twisted bilayer graphene, monolayer copper superconductors, and quantum spin Hall materials, has demonstrated both important scientific implications and promising application potential. To characterize the electronic structure of these materials/devices, ARPES is commonly used to measure the energy and momentum of electrons photoemitted from samples illuminated by X-ray or vacuum ultraviolet (VUV) light sources. Although the X-ray-based spatially resolved ARPES has the highest spatial resolution (~100 nm) benefitting from the relatively short wavelength, its energy resolution is typically mediocre (>10 meV), which makes it difficult to visualize the fine details of the electronic structure in many novel quantum materials. Complementary to X-ray light sources, VUV laser-based light sources can offer much better energy resolution (~0.2 meV), deeper depth of detection and lower cost (compared to synchrotron light sources). However, the longer wavelength of the VUV light source also deteriorates its spatial resolution (typically several micrometres to date), making it insufficient for characterizing small-size flake samples or spatially inhomogeneous (e.g., magnetic, electronic or composite domain) materials.

In a new paper published in Light Science & Applications, Mao and his co-workers have developed a 177 nm VUV laser system for scanning photoemission microscopy with a focal spot of...
