

Atom-at-a-time Chemistry: From Actinides to Superheavies

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The chemical properties of heavy elements are anticipated to diverge from established periodic trends due to significant relativistic effects. However, experimental investigations in this region remain extremely challenging and necessitate the use of nuclear physics techniques. This is especially true for the late actinides ($Z > 100$) and superheavy elements ($Z > 104$), where studies are limited to atom-by-atom analyses. To date, no experiments have definitively identified molecular species formed by elements with $Z > 99$, leaving their reactivity largely unexplored. A novel experimental technique developed at Lawrence Berkeley National Laboratory now allows for the direct identification of molecular species through mass-to-charge ratio measurements. This advancement has enabled new chemical studies of actinium (Ac, $Z = 92$) and nobelium (No, $Z = 102$), representing the respective bookends of the actinide series. These efforts pave the way for a new era of experiments to probe the chemistry of superheavy elements, providing quantifiable insights and facilitating deeper exploration into the uncharted regions of the periodic table. Recent experimental results and future directions will be presented.

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