Water Cluster Advances for Biological SIMS: From Beam Chemistry to Cryogenic Conditions

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Low ionisation yields remain one of the central challenges in SIMS analysis of biological materials. Numerous strategies have been explored to address this, including matrix addition, metal coating, and laser post-ionisation. Among the most promising approaches is the introduction of proton-donating molecules, either directly to the sample, the surrounding atmosphere, or the ion source. Water has proven to be a particularly attractive candidate as it is inexpensive, safe, and effective at enhancing ionisation efficiency. The adoption of water gas cluster ion beams (GCIB) has delivered significant benefits, both improving ionisation yields and reducing matrix effects [1]. Further work on doping these clusters with reactive gases has amplified these beneficial effects [2], and allowed for analysis of multiply charge small proteins [3]. This also translated to increased yield and improved imaging capabilities for cholesterol which has historically proven difficult to ionise and analyse using mass spectrometry techniques [4]. Cryogenic analysis is important for maintaining morphology and localisation in high resolution tissue imaging and as a means of better preserving sample chemistry [5]. Our research is investigating the fundamental parameters that determine to what extent large water clusters affect sputter and ionisation efficiency, and what role cryogenic conditions might play in this process.

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