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Chemical Imaging of Lipid Domains by High-Resolution Secondary Ion Mass Spectrometry

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Lipid microdomains within supported lipid bilayers composed of binary phosphocholine mixtures were chemically imaged by high-resolution secondary ion mass spectrometry performed with the NanoSIMS 50 (Cameca Instruments). This instrument images the sample components based on the elemental or isotopic composition of their atomic and small molecular secondary ions. Up to five different secondary ions can be simultaneously detected, and a lateral resolution of 50 nm can be achieved with high sensitivity at high mass resolution. In our experiments, the NanoSIMS 50 extensively fragmented the supported membrane, therefore an isotopic labeling strategy was used to encode the identities of the lipid components. Supported lipid membranes that contained distinct lipid microdomains were freeze-dried to preserve their lateral organization and analyzed with the NanoSIMS 50. Lipid microdomains as small as 100 nm in diameter were successfully imaged, and this was validated by comparison to AFM images taken at the same region prior to chemical imaging. Quantitative information on the lipid distribution within the domain was also determined by calibrating against supported membranes of known composition. We believe this will be a valuable approach for analyzing the composition of complex membrane domains with high spatial resolution.

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