

**Every ligand counts: Quantitative analysis of nanoparticle surface ligands  
via TD-DART-MS**

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The characterization of surface ligands on colloidal nanoparticles remains an underdeveloped area of research. The methods currently used for surface characterization often lack specificity and sensitivity, making the identification of specific ligands and ligand mixtures complicated, if not impossible. To overcome these limitations, thermal desorption–direct analysis in real-time–mass spectrometry (TD-DART-MS) was used to discriminate between bound and unbound species in colloidal suspensions of cadmium selenide quantum dots (QDs). Beyond the identification of bound species, we show that this method allows for the quantitative analysis of ligands on the surface of QDs. The oleate coated QDs were analyzed and the quantity of oleate was determined by an external calibration curve constructed based on oleic acid standard solutions. The  $^1\text{H}$  NMR was used as a reference method to validate the quantitative results for oleate ligands. Our study demonstrates TD-DART-MS as a valuable tool to study surface chemistry of QDs.