

GAS PHASE REACTION DYNAMICS AND
DESIGN OF MOLECULAR CLUSTERS
AND BIOCONJUGATES

Thesis by

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Abstract

Chapter 1 serves as an introduction to the design of molecular clusters and bioconjugates that exhibit interesting reactivity in the gas phase. In Chapter 2, gas-phase reactions of clusters of alkylammonium ions with triphosphate, DNA, and peptides are examined. Alkylation of both phosphate and carboxylate groups is observed. In Chapter 3, the gas phase reactions of methyl phosphate noncovalently bound clusters are studied in detail. The presence of sodium ions in methyl phosphate clusters stabilizes the clusters, facilitating intermolecular condensation reactions between methyl phosphates.

In Chapter 4, the first gas-phase phosphorylation of molecules containing hydroxyl substituents is reported. Gas-phase reactions of triphosphate with hydroxyl-containing molecules result in phosphorylation of the hydroxyl substituent. In the absence of a hydroxyl substituent, the C-terminus of a peptide can be phosphorylated. Otherwise, hydroxyl residues are selectively phosphorylated.

Chapter 5 considers the possibility of free radical initiated peptide sequencing, or FRIPS, in the gas phase. A free radical initiator is conjugated to the N-terminus of peptides or proteins, forming a bioconjugate. Collision-induced dissociation of the conjugated species results in free radical formation. The free radical then fragments on further collisional activation to yield backbone fragmentation products. This technique may allow selective cleavage of peptides at specific amino acid residues, with applications to gas-phase proteomics sequencing efforts.

Chapters 6 deals with experiments conducted on solvated ions, specifically focusing on the evaporation kinetics and the relative intensities of differently solvated species. Water cluster distributions are used to discriminate between isomers and

enantiomers. Chapter 6 also includes data on the reaction of *t*-butyl chloride in water clusters, as well as data on doubly charged cationic species showing pairwise evaporation of water.

Chapter 7 uses H/D exchange experiments to examine the behavior of sodiated glycine oligomers, ranging from Gly₁ to Gly₅. It is found that H/D exchange dynamics do not directly reflect the structure of sodiated glycine oligomers, as the solvation energy provided by the exchange reagent can allow the ion-molecule complex to access high-energy states. Therefore, interpretations of H/D exchange results should be conducted with detailed examinations of possible exchange mechanisms.

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