Control of the fragmentation dynamics of bromochloroalkanes

A. Wirsing, J. Plenge, I. Wagner-Drebenstedt, I. Halfpap, and E. Rühl

Institut für Chemie und Biochemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin, Germany

We report on the coherent control of the ultrafast ionization and fragmentation dynamics of bromochloroalkanes ($C_nH_{2n}BrCl$, n = 2, 3) using shaped ultrafast laser pulses (λ = 804 nm) and femtosecond pump-probe experiments. Evolutionary algorithms are applied in a feedback loop in order to optimize the intensity of selected fragment ions. The time structure of the optimal pulses that result in an enhancement of the fragment ions and at the same time in a depletion of the parent ion shows a characteristic sequence of pulses. Typically, a less intense probe pulse follows an intense pump pulse where optimal time delays of 300 – 500 fs in the control experiments on C_2H_4BrCl and C_3H_6BrCl are observed. The interpretation of the underlying control mechanism is achieved with the results from one-color 804 nm pump-probe experiments. The ion yields of the parent molecule and several fragments show broad dynamic resonances with a maximum at 300 – 500 fs. The experimental findings are explained in terms of an enhanced fragmentation during the dissociative ionization of $C_nH_{2n}BrCl$ (n = 2, 3). The importance of dynamic resonances on the fragmentation dynamics of $C_2H_4BrCl^+$ and $C_3H_6BrCl^+$ are discussed.