**Description of Additional Supplementary Files**

File Name: Supplementary Data 1  
Description: Time of Flight Mass Spectra recorded between 7.3-8.0 eV with 300 Torr Helium backing pressure and MgF2 window in path of synchrotron beam of the C7H7 self reaction.

File Name: Supplementary Data 2  
Description: Time of Flight Mass Spectra recorded between 7.3-8.0 eV with 300 Torr Helium backing pressure and MgF2 window in path of synchrotron beam of the C7H7 self reaction.

File Name: Supplementary Data 3  
Description: Time of Flight Mass Spectra recorded between 7.3-8.0 eV with 300 Torr Helium backing pressure and MgF2 window in path of synchrotron beam of the C7H7 self reaction.

File Name: Supplementary Data 4  
Description: Time of Flight Mass Spectra recorded between 8.0-10.0 eV with 300 Torr Helium backing pressure of the C7H7 self reaction.

File Name: Supplementary Data 5  
Description: Time of Flight Mass Spectra recorded between 8.0-10.0 eV with 300 Torr Helium backing pressure of the C7H7 self reaction.

File Name: Supplementary Data 6  
Description: Time of Flight Mass Spectra recorded between 8.0-10.0 eV with 300 Torr Helium backing pressure of the C7H7 self reaction.

File Name: Supplementary Data 7  
Description: Cartesian coordinates (in Å) and vibrational frequencies (in cm-1) for reactants, intermediates, transition states, and products along reaction pathways leading to phenanthrene and anthracene shown in Figure 1.