Photo induced dissociation of hydrogenated pyrene molecules

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Synopsis The resistance of hydrogenated Polycyclic Aromatic Hydrocarbons against carbon-backbone fragmentation is dependent on their degree of hydrogenation. We have measured the response of hydrogenated pyrene ($C_{16}H^+_{10+m}$, $m = 0, 6$, or 16) to photo excitation by measuring the respective fragmentation yields. Our results show that a higher degree of hydrogenation correlates with a lower resistance of the pyrene carbon-backbone against fragmentation.

It has been suggested that super-hydrogenated Polycyclic Aromatic Hydrocarbons (HPAHs) may play a role in the formation of H_2 in the interstellar medium, but only a few experimental measurements of the stability of HPAHs have been reported [1, 2, 3]. However, while hydrogenated coronene ($C_{24}H^+_{12+m}$, $m = 0$–7) irradiated by soft x-rays showed resistance against carbon backbone fragmentation [1], hydrogenated pyrene ($C_{16}H^+_{10+m}$, $m = 0, 6$, or 16) was more susceptible to carbon backbone fragmentation in collision induced dissociation (CID) experiments [2, 3].

Here we present photo fragmentation experiments of hydrogenated pyrene cations ($C_{16}H^+_{10+m}$, $m = 0, 6$, or 16, see Figure 1) performed at the ELISA storage ring at Aarhus University [4]. Ion bunches were accelerated to 22 keV and injected into the storage ring, where they were overlapped with a laser pulse ($E \simeq 3$ eV/photon).

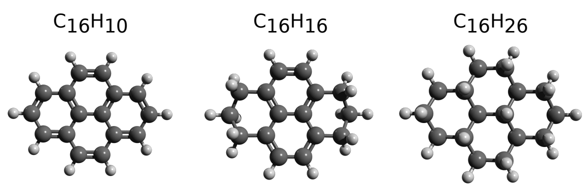

Figure 1. Structures of $C_{16}H_{10}$, $C_{16}H_{16}$, and $C_{16}H_{26}$

In Figure 2 the fragmentation yields as a function of laser pulse energy, P, are shown. P is decreased by attenuating the laser beam for a fixed wavelength. The fragmentation yield is then proportional to P^n, where n is the number of photons absorbed before fragmentation. We find that pristine pyrene ($m = 0$) absorbs $n = 3$ photons ($E_{total} = 8.17$ eV), hexahydropyrene ($m = 6$) absorbs $n = 2$ photons ($E_{total} = 5.77$ eV), and hexadecahydropyrene ($m = 16$) absorbs $n = 1$ photons ($E_{total} = 2.95$ eV), both for the total fragmentation and individual fragmentation channels [5].

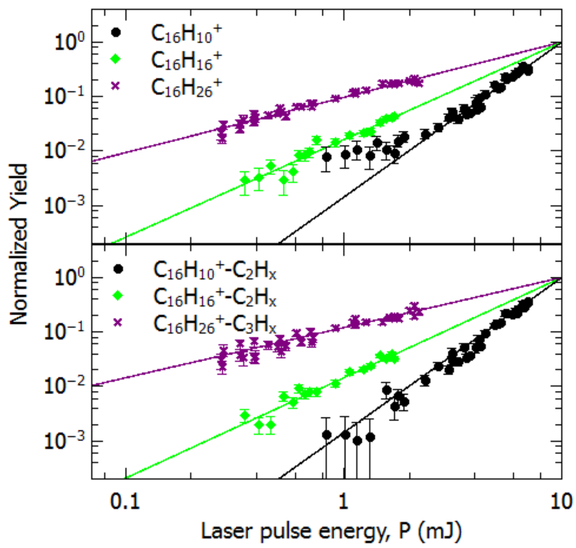

Figure 2. Top panel: Photo-dependencies of the total fragmentation of $C_{16}H^+_{10+m}$, $m = 0, 6$, or 16
Bottom panel: Photo-dependencies of individual fragmentation channels of $C_{16}H^+_{10+m}$, $m = 0, 6$, or 16

The power dependencies show that hydrogenation weakens the carbon backbone of pyrene against low energy photon fragmentation, and support the previous CID results.

References

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