

# Supporting Information

## Scalable Low Cost Fabrication of Disposable Paper Sensors for DNA Detection

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Transitions of the core electrons to another bound state of higher principal quantum number (Rydberg orbital), which are diffuse and extended in space has been well established.<sup>1,2</sup> Excitations to  $\sigma^*$  generally will be higher in energy than those to Rydberg orbitals because the Rydberg orbitals are nonbonding whereas the  $\sigma^*$  MOs are antibonding and are mainly found above the ionization potential. Stohr et.al. reported the identification of C-H resonances using NEXAFS and its significance in the study of hydrocarbon molecules.<sup>3</sup> Outka et. al.<sup>4</sup> observed strong C-H resonances for condensed alcohols on Si surfaces at 288.1 eV and 289.4 eV and C-C  $\sigma^*$  resonance 292.8 eV. Knorr et.al. in their NEXAFS study of amino silane assigned 289 and 290 eV peaks to C-H resonances.<sup>5</sup>

In the presence of bonds to hydrogen atoms, mixing of Rydberg orbitals with hydrogen-derived antibonding orbitals of the same symmetry increases the intensity of the corresponding resonance.<sup>6,7</sup> Urquhart et al. in their study on gaseous alkanes observed that the valence character decreases as the number of C-H bonds decreases and concluded that in gaseous alkanes there can only be Rydberg valence mixing when there is a valence orbital of appropriate

symmetry and energy.<sup>6</sup> Urquhart et.al.<sup>8</sup> in their study on gaseous and condensed phase neopentane observed that both the theoretical and experimental results showed quenching of Rydberg states in solid phase. Weiss et al.<sup>9</sup> studied in detail the Rydberg transitions in condensed alkanes located between 287.4 and 288.1 eV and reported that the excited Rydberg states are not quenched but retain a definite excitonic character and are blue shifted. Strong presence of Rydberg states in solids is demonstrated by Bagus et al.<sup>10</sup> and they also reported that the C K edge NEXAFS spectra of alkanes show pronounced features below the ionization potential that are best described as mixed Rydberg/Valence resonances. Ishi and Hitchcock<sup>11</sup> in their investigation of alcohols attributed the 289.4/289.2 eV peaks to excitations of a mixed Rydberg/Valence orbital.

Urquhart et.al.<sup>12</sup> reported N1s  $\rightarrow$ 3s and N1s  $\rightarrow$ 3p Rydberg transitions in gas phase urea at 401.5 eV and 402.7 eV respectively, indicating a decrease in Rydberg transitions with decreasing NH<sub>2</sub> groups. In a comparison of gaseous and condensed glycine, Gordon et.al.<sup>13</sup> observed a striking difference between the gaseous and condensed phase Rydberg transitions. For gaseous glycine, the peaks at 401.3 eV and 402.5 eV were assigned as N1s $\rightarrow$ 3S Rydberg and N1s $\rightarrow$ 3p Rydberg transition respectively. However, both these features were absent in the condensed phase. Otero et.al.<sup>14</sup> studied the N1s NEXAFS of amino acids and concluded that the attenuation of Rydberg transitions in condensed phase is due to intermolecular effect, where the presence of neighboring molecules in the solid disrupts the Rydberg orbitals leading to their attenuation. In the N 1s NEXAFS spectrum there are uncertainties about the Rydberg transitions, which are left unassigned.

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