In Situ Scanning Tunneling Microscopy of DNA-Modified Gold Surfaces: Bias and Mismatch Dependence

Donato M. Ceres and Jacqueline K. Barton*

Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, California 91125

jkbarton@caltech.edu

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Abstract:

In situ scanning tunneling microscopy has been performed on DNA-modified gold surfaces under physiological conditions. The STM images of DNA-modified gold surfaces are strongly dependent on the applied potential and percentage of DNA duplexes containing a single base mismatch. At negative surface potentials we observe reproducible features that are attributed to DNA agglomerates where the DNA duplexes are in the upright orientation; at positive potentials, when DNA molecules lie down on the surface, the film is transparent, and only the gold surface is distinguishable. These observations indicate that DNA possesses a non-negligible local density of states which can be probed when the DNA duplex is in the upright orientation. By varying the percentage of DNA duplexes containing a single base mismatch, we have observed a dramatic change in the image contrast as a result of the perturbation induced by the mismatch on the electronic pathway inside the DNA. These results emphasize the central role of the integrity of the π-stack for DNA charge transport. Duplex DNA is a promising candidate in molecular electronics, but only in arrangements where the orbitals can efficiently overlap with the electronic states of the electrodes and the environment does not constrain the DNA in non-native, poorly stacked conformations.