Nanobubbles: the hidden force inducing molecular binding on biochips

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The influence of nanobubbles on molecular binding on gold-coated surfaces has been studied using a quartz crystal microbalance. We found that changes in resonant frequency during oligonucleotide immobilization in degassed buffers were similar to those in air-rich solutions. However, during hybridization of immobilized and complementary oligonucleotide strands, no decrease in frequency was observed in degassed buffer solutions, indicating that no hybridization occurred. In contrast, a substantial decrease was observed in air-rich solutions. The differential effect of nanobubbles on immobilization and hybridization events was attributed to the nature of the underlying molecular interactions: covalent bonding for immobilization and noncovalent bonding for hybridization. Similarly, upon exposure of an antithrombin-immobilized surface to a thrombin-containing solution, decreases in frequency corresponding to specific binding were observed only in air-rich buffer solutions, supporting the hypothesis that nanobubbles play a key role in molecular binding on gold surfaces.