Acoustic wave biosensors as a powerful tool for measuring molecular conformation and developing diagnostic platforms

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The development of biophysical tools for the characterization of the conformation of biomolecules is of significance to biosciences and nanobiotechnology. Acoustic wave devices, traditionally used to detect the mass of surface-attached analytes, can now provide structural information by correlating the two signals obtained during acoustic monitoring (i.e., the energy and frequency of the wave) to the hydrodynamic properties of the attached biomolecule or bio-entity. This novel approach, developed in our lab during the last few years, has been shown both theoretically and experimentally to be able to provide quantitative information on the size and shape of biomolecules[1,2]. Specifically, a mathematical model was derived and used to correlate acoustic measurements to the hydrodynamic properties of the attached analyte, namely its intrinsic viscosity and radius of gyration. The validity of the approach was shown by using acoustic devices to a) discriminate DNA molecules of the same size but different shape or same shape and different size[2]; b) follow the dynamic change and characterize the structure of a DNA nanoswitch[3] and of an intrinsically disordered protein[4], both undergoing conformational changes upon exposure to an environmental trigger; and, c) follow hybridization events by monitoring the shape of a surface-immobilized probe and its transition to the hybridized product[5]. The concept of conformation sensing, was finally exploited for the development of an integrated Lab-on-chip system for pathogenic DNA detection in food and human samples.

References

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