Development of High-sensitivity, high-precision quartz crystal microbalance (QCM) immunosensor system

Suitable for rapid analysis of environmental pollutants, disease markers, and allergens

We have developed a high-sensitivity, high-precision quartz crystal microbalance (QCM) immunosensor system (QCM system) with a flow cell. The stability of the oscillating frequency of QCM in a solution was a serious problem with conventional QCM systems. We successfully improved the stability by more than one order of magnitude by decreasing the phase noise: this resulted in a highly-sensitive, highly precise and rapid measurement of an immunoreaction.

This QCM system allows us to detect the presence of a target substance with high selectivity. A substance (antibody or antigen) that binds specifically to the target substance (antigen or antibody respectively) is immobilized on the gold electrode surface of the QCM-sensor. When the antibody binds to the antigen, there occurs a detectable change in the oscillating frequency of the QCM-sensor device. We expect this QCM-system to be useful in highly sensitive, very precise analyses of substance such as dioxins, endocrine disruptors, pesticide residues, allergens, stress markers, disease markers, and pathogenic microbes.

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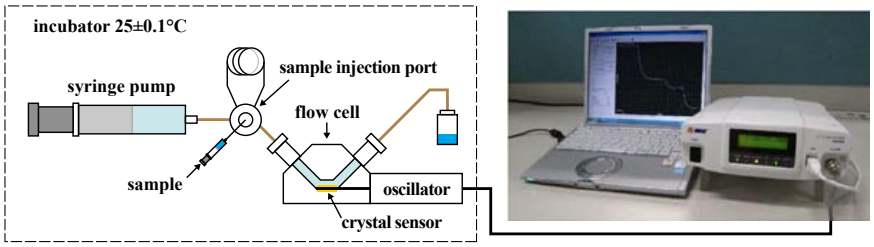
AIST TODAY Vol.7, No.11 p.19 (2007)



Schematic diagram of the flow-type QCM immunosensor system

Magnetic levitation densimeter for PVT property standard

A magnetic levitation densimeter (MLD) is developed to provide precise pressure-volume-temperature (PVT) property standard data for several novel fluids such as non-fluorinated refrigerants, hydrogen and bio-fuels. On the basis of the solid density artifact in which density is traceable to the primary density standard realized by silicon single-crystal spheres, fluid density can be measured by simple Archimedes principle. By using MLD, one can measure fluid density *via* magnetic coupling which transmit the buoyancy force through the pressure barrier. The bottleneck of this method was the force transmission error of the magnetic coupling to surrounding materials, and it results in an error of about 100 ppm in density measurement. Based on finite element method (FEM) analysis, we have proposed a dual-sinker weight exchanging system. By weighing two density-different sinkers at the same vertical levitation height, fluid density is obtained without any errors related to the magnetism of materials.

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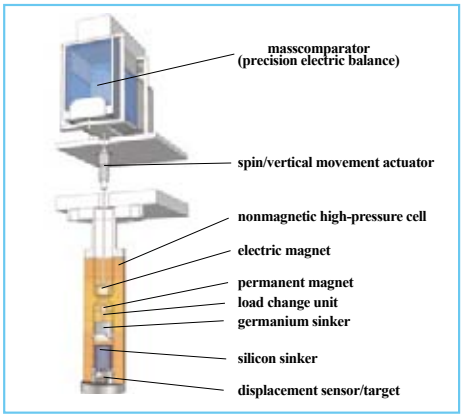
TODAY Vol.7, No.10 p.28 (2007)



Dual-sinker magnetic levitation densimeter