

COUPLE GAS SORPTION CALORIMETRY OF BIOMOLECULAR NANOCOMPLEXES
INTRODUCTION

Water adsorption and hydration influence the behavior of drug delivery nanocarriers in physiological environments, including their colloidal stability and transport, the protein corona formation, and biological interactions.

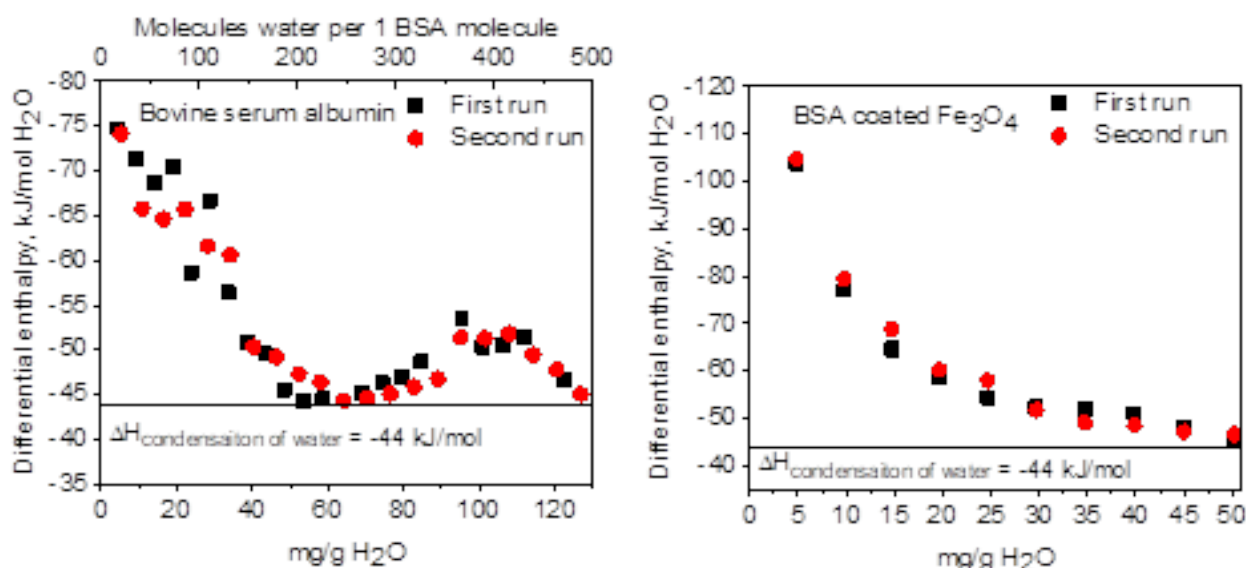
This application note demonstrates how the SETARAM Calvet PRO calorimeter (formerly Sensys Evo) coupled with a gas dosing system can directly measure water adsorption energetics on free biomolecules and biomolecule coated nanoparticles.

EXPERIMENT

Coupled gas sorption calorimetry combines precise water vapor dosing, volumetric adsorption measurements and simultaneous calorimetric detection.

Small doses of water vapor were stepwise released into the system at room temperature. Each dose generated an exothermic calorimetric peak recorded by the calorimeter. The simultaneous record of the amount of adsorbed water and the heat effect provided a high resolution measurement of the differential heat of adsorption as a function of surface coverage and amount of adsorbed water in mg/g sample. Unlike adsorption isotherms alone this methodology **directly measures the differential enthalpy of adsorption**.

The methodology was applied to magnetite nanoparticles coated with bovine serum albumin (BSA), potato starch, and lauric acid representing protein, polysaccharide, and lipid-type biomolecular interfaces.



Differential enthalpy of adsorption of water on free bovine serum albumin (left) and BSA coated nano magnetite (right). The horizontal straight line corresponds to the enthalpy of condensation of bulk water and indicates the end of the chemisorption process. Adapted from (1).

RESULTS

The measurements revealed how the surface functionalization with proteins, polysaccharides, and fatty acid affects the hydrophilicity and the hydration capacity of the nanocomplexes, which can provide a basis for engineered nanocarriers with tailored colloidal stability, immune interactions, and drug delivery behavior.

CONCLUSION

The SETARAM Calvet PRO coupled gas sorption calorimetry platform enables direct measurement of hydration energetics on biomolecularly functionalized nanomaterials. The methodology provides quantitative insight into water interactions at nano–bio interfaces and extends the calorimetric technique to biologically relevant inorganic-organic systems.

Potential applications include nanomedicine, biomaterials, drug delivery systems. functionalized nanoparticles, biointerfaces, soft hybrid materials.

1. K. Lilova, T. Subramani, I. Montini, A. Harrison, M. Scharrer, J. Wu, H. Xu, A. Navrotsky, Primary biomolecular adsorption energetics of core-shell nanocomplexes: Implications for biological interactions, Proc. Natl. Acad. Sci. U.S.A. 123 (10) e2535339123, <https://doi.org/10.1073/pnas.2535339123> (2026).

INSTRUMENT

CALVET PRO

