Thermal-Conductivity Measurement as a Tool to Probe the Conformational Dynamics of Proteins

Byoung Kyoo Park [S] and Namwoo Yi
POSTECH, Department of Mechanical Engineering, Pohang, Korea

Jaesung Park
POSTECH, School of Interdisciplinary Bioscience and Bioengineering, Pohang, Korea

Dongsik Kim [C]
POSTECH, Department of Mechanical Engineering, Pohang, Korea
dskim87@postech.ac.kr

Proteins, as essential components in biological cells, carries out critical physiological activities in biological cells and therefore numerous studies have been performed to elucidating the characteristics. In particular, denaturation of proteins has been studied using various experimental techniques including calorimetric methods. In thermal analysis using differential scanning calorimetry (DSC), the enthalpy and heat capacity changes are measured during denaturation. The DSC analysis discloses the thermodynamic conditions under which denaturation occurs, and quantifies the enthalpy of denaturation. However, unlike the thermodynamics associated with denaturation, relatively little attention has been paid to the thermal transport process, i.e., thermal conductivity of proteins. In this work, we analyze the relation between the thermal conductivity of aqueous solutions of several proteins including bovine serum albumin (BSA) and their denaturation processes. The three-omega method with a microfabricated ac thermal sensor is employed to measure the thermal conductivity of the protein solutions by varying the concentration, acidity and temperature. The results demonstrate a strong correlation between denaturation of the proteins and the thermal conductivity of the aqueous solutions, suggesting that the thermal conductivity can be exploited to monitor the conformational dynamics of proteins. The technique of protein analysis demonstrated in this work is expected to be useful in micro-total-analysis systems as it is easier to miniaturize and to integrate into a device than is conventional DSC analysis.