PR4 Project Research on Development of Scattering Spctrometers Utilizing Small and Medium Class Neutron Source

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Objectives and Allotted Research Subjects: It is no doubt that Small-angle neutron scattering is one of the most powerful tools to investigate nanoscale structures in variety of materials. However, the less opportunity to do SANS is a bottleneck that SANS becomes general method to observe nanoscale structure. Utilizing small and medium size reactor as a neutron source for SANS spectrometer gives one answer for this difficulty. Under this line, this project proves it through showing the feasibility and upgrade of KUR-SANS.

ARS-1: Challenge for Development of Analyzer for Particle-Size distribution with Small-Angle Scattering. (M. Sugiyama, R.Inoue, N.Sato and Y. Oba)
ARS-2: Are Size Upgrading of Compact Monochromator for SANS. (M. Hino, Y. Oba, M.Sugiyama, T. Oda and S.Tasaki)
ARS-3: Structural Analysis of PVA gel by adding Inorganic Salt (R.Inoue, Y. Oba, N. Sato, T.Kanaya and M. Sugiyama)
ARS-4: Estimation of Fine Structure in Metallic Materials by SANS (Y. Oba, S.Morooka, M. Ohnuma, N. Sato, M. Sugiyama)
ARS-5: KUR-SANS Observations and Analysis Surfactants' Nano-structural Change by Capturing Heavy Metal. (K. Hara, T. Miyazaki, Y. Oba, N. Sato, M. Sugiyama, Y. Hidaka and H. Okabe,)
ARS-6: Small-Angle Neutron Scattering Analysis of the Nanostructure of Wheat Proteins. (R. Urade, Y. Higashino, S.Funaki, Y.Kitao, N. Sato and M. Sugiyama)
ARS-7: Structural Investigation on Radiation-Fabricated Functional Gel. (N. Sato, Y. Oba and M. Sugiyama)
ARS-7: Quantitative Analysis for TiN particle by Effect of Thermal Weld in Steel (S. Morooka, Y. Oba, and M. Sugiyama)
ARS-8: Nano structure of metal hydride by neutron small angle scattering. (K. Iwase, K. Mori, Y.Oba and M. Sugiyama)

Main Results and Contents of This Project:
ARS-1: Not performed by no operation of KUR.
ARS-2: Not performed by no operation of KUR.
ARS-3: Not performed by no operation of KUR.
ARS-4: Not performed by no operation of KUR.
ARS-5: Hara et.al. continued to analyze nano-structural change of a surfactant (Sodium Oleate, NaOl) with KUR-SANS. (The data was obtained in 2013). They analyzed the surfacta system with pair distance distribution function and revealed spherical scatterers in the solution.
ARS-6: Not performed by no operation of KUR.
ARS-7: Not performed by no operation of KUR.
ARS-8: Not performed by no operation of KUR.

採択課題番号 26P4 中小型中性子源を用いた散乱分光システムの開発 プロジェクト
（京大・原子炉） 杉山正明

PR4-1

KUR-SANS Observations and Analyses of Surfactants' Nano-structural Change by Capturing Heavy Metal

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INTRODUCTION:

Ion flotation is well-known as a simple and useful method to remove hazardous ions or to recover valuable ions [1,2]. Besides, because the surfactants are known to exhibit various nano-scale structural changes in the flotation process as scavengers or collectors, such a nano-structural change will be useful for examining the performance of KUR-SANS system installed at Research Reactor Institute, Kyoto University. Therefore, in the present study, the nano-structural changes of a surfactant (Sodium Oleate, NaOl) in the floatation process have been investigated.

EXPERIMENTS:

$CuCl_2$ (5 mM) was added to respective NaOl (30 mM)-D_2O solutions after adjusting their pH's at 7, 8, 10 and 12 with HCl and NaOH. Then the solutions were bubbled for 10 min and were poured into quartz cells for the SANS measurements. The SANS profiles were measured at room temperature with the KUR-SANS system (CN-2) with a 2.8 Å neutron beam.

RESULTS:

Figures 1 and 2 show SANS profiles of the $CuCl_2$-added Sodium Oleate in D_2O at several pH's before and after the flotation, respectively. Except for the pH=12 specimen, the lower-*q* region intensity decreased greatly indicating the larger substances are effectively recovered by flotation. In the present study, the SANS profiles have been further analyzed with pair distance distribution functions (PDDF) for deriving semi-quantitative scatterer-shape information [3]. As an example, the PDDF of Cu-added pH=10 specimen is shown in Fig. 3, of which the well-defined symmetric bell-shape indicates the existence of spherical scatterers in the solution. Such features demonstrates a high quality of the SANS profiles measured by the KUR-SANS system.

REFERENCE:

[1] F. Sebba, *Ion flotation* (Elsevier, Amsterdam, 1962)
[2] E. J. Mahne and T. A. Pinfold, J. Appl. Chem., **18** (1968) 52-54
[3] O. Glatter, J. Appl. Cryst., **10** (1977) 415-421

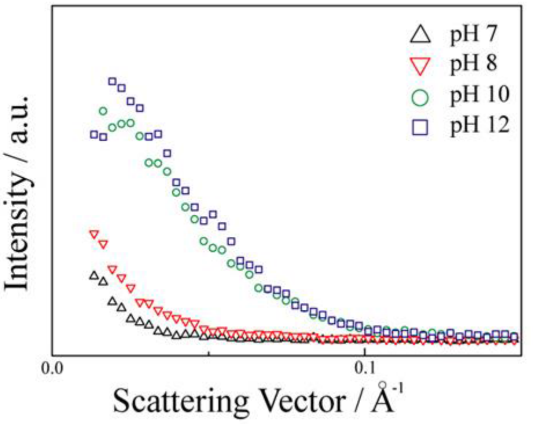

Fig.1 SANS profiles of Sodium Oleate in D_2O containing $CuCl_2$ before flotation.

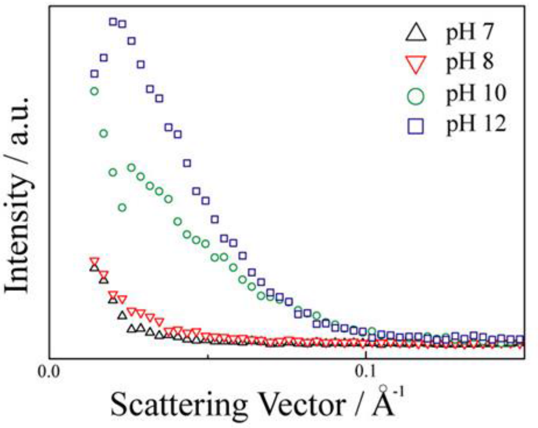

Fig.2 SANS profiles of Sodium Oleate in D_2O containing $CuCl_2$ after flotation.

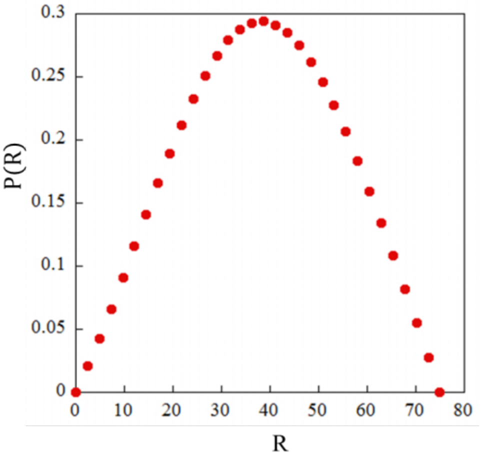

Fig.3 Pair distance distribution function of Sodium Oleate in D_2O containing $CuCl_2$.

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(九大院工) 原 一広、宮崎智博
(京大原子炉) 佐藤信浩、大場洋次郎、杉山正明