

Quantitative Evaluation of Washing Effects on Inside Cotton Fibers by ATR-FT/IR and TOF-SIMS

Ayumi Isaka^{1*}, Natsuki Masujima¹, Shinji Ando², and Akio Kuzuhara¹.

¹Department of Costume and Clothing Science, Faculty of Home Economics, Tokyo Kasei University, Kaga 1-18-1, Itabashi-ku, Tokyo 173-8602, Japan

² Department of Chemical Science and Engineering, Tokyo Institute of Technology, Ookayama 2-12-1-E4-5, Meguro-ku, Tokyo 152-8552

* E-mail address: ayumi.060606.runrun@gmail.com

To investigate the washing effects of various soil components adhering or adsorbing to cotton fiber in the depth direction, the detergency of soil components adhering to wet-type artificially soiled fabrics washed with soap (sodium fatty acid) was quantitatively evaluated by attenuated total reflection (ATR)-FT/IR method using Ge (refractive index: $n=4.0$) and ZnSe ($n=2.40$) prisms. Furthermore, the amount of oil-based soil (oleic acid compounds) adsorbing inside the fiber was elucidated using time-of-flight secondary ion mass spectroscopy (TOF-SIMS). The relationships between the detergency of oil- and protein-based soil components and the washing time using Ge and ZnSe prisms with different penetration depths are shown in **Fig. 1**, respectively. The detergency of both oil- and protein-based soil components increased with an increase in washing time. In addition, it should be noted that the detergency of artificially soiled fabrics evaluated by Ge prism was higher than that by ZnSe prism, indicating that soils closer to the surface were preferentially removed than those inside the fiber. The negative secondary ion image of the cross-section of artificially soiled fabric is shown in **Fig. 2**. It was found that the oleic acid compounds were not uniformly adhered and distributed within single yarns of cotton fibers and were removed by increasing the washing time. In addition, the relative intensities of oil-based soil components adhered to the artificially soiled fabrics evaluated by ATR-FT/IR agreed well with the result of TOF-SIMS. Based on these experimental findings, oil-based soil components adhering to the surface and those adsorbed inside fiber were effectively removed by washing with soap.

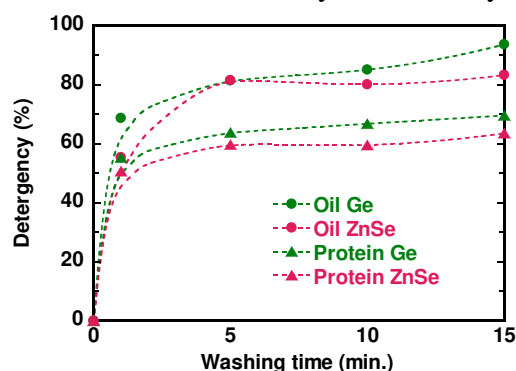


Fig. 1 Relationship between the detergency of oil- and protein-based soil components and the washing time using Ge and ZnSe prisms with different penetration depths

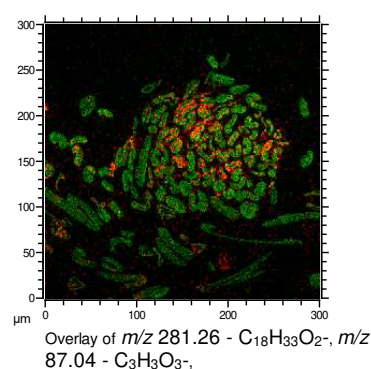


Fig. 2 Negative secondary ion image of the cross-section of artificially soiled fabric: Cellulose (green), oleic acid compounds (red)

Keywords: ATR-FT/IR, TOF-SIMS, Ge and ZnSe prisms, artificially soiled fabrics, oil-based soil components, protein-based soil components