Stroboscopic approach for the quantitative X-ray phase imaging of periodic processes in soft materials using X-ray Talbot interferometry

Margie P. Olbinado*, Patrik Vagovič[1], Wataru Yashiro[1] and Atsushi Momose[1]

Dept. of Advanced Materials Science, Graduate School of Frontier Sciences, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8561, Japan
[1]Institute of Materials Research for Advanced Materials, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai, Miyagi 980-8577, Japan

X-ray phase imaging is a valuable tool for non-destructive visualization of soft materials such as biological tissues and polymers. Because it is a non-invasive imaging technique, x-ray phase imaging is a very good candidate for the investigation of many dynamic processes in soft materials [1]. However, the realization of quantitative X-ray phase imaging with a good temporal and spatial resolution remains a challenge [2-5]. A demonstration of the new time-resolved imaging technique called the stroboscopic X-ray Talbot interferometry that is applicable for the visualization of periodic processes in soft materials will be presented. X-ray phase imaging was performed via the phase stepping technique in which each moiré image was obtained by repeatedly acquiring an image of a specific phase of a motion in which an object was captured "frozen in time". This technique achieves a quantitative X-ray phase imaging, which was not easily achieved by the recent reports using propagation-based and analyzer-based methods. A microsecond temporal resolution was achieved in contrast with the previously reported millisecond temporal resolution using non stroboscopic X-ray Talbot interferometry with white synchrotron radiation [5]. Figure 1 shows the X-ray differential phase image of a PMMA sphere moving at 1.4 ms/ captured stroboscopic with a camera exposure time of 8 μs in comparison with a non-stroboscopic image captured at 0.3 ms.

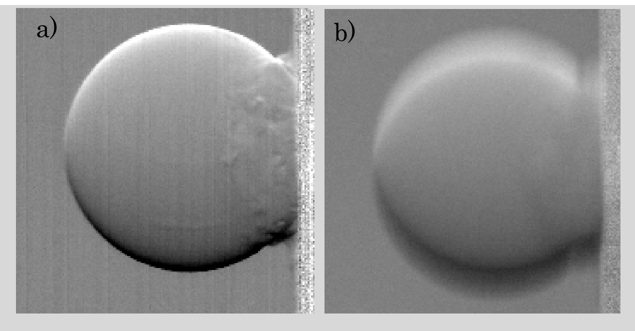

Fig. 1. X-ray differential phase images of a PMMA sphere (ϕ = 3.2mm) attached at the edge of a disk rotating at 5 rev/s. The sphere was moving at 1.4 m/s downward and captured: (a) stroboscopic with 8 μs exposure time, and (b) non-stroboscopic with 0.3 ms exposure time.

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