An *in situ* analysis of EUV resist dissolution characteristics by high speed AFM

Julius Joseph Santillan and Toshiro Itani
EUVL Infrastructure Development Center, Inc. (EIDEC),
16-1 Onogawa, Tsukuba, Ibaraki 305-8569, Japan

The authors have proposed the use of in-liquid high speed atomic force microscopy (HS-AFM) for analyzing resist dissolution *in situ*[1]. Significant system and methodology improvements have allowed the analysis of 32 nm half pitch (hp) lines and spaces (L/S)[2] of positive tone extreme ultraviolet (EUV) resists developed in 0.26N aqueous tetramethyl ammonium hydroxide (aq. TMAH).

In recent years, negative tone development (NTD) resists using organic solvent developers have gained attention in EUV lithography for the advantage it provides in trench and contact hole patterning applications[3]. However, further fundamental investigations are necessary. One such fundamental analysis is the *in situ* dissolution characterization of NTD resist patterns using the HS-AFM.

In this paper, the first *in situ* characterization results of NTD resist pattern dissolution utilizing an organic solvent developer is presented. Figure 1 shows the preliminary dissolution analysis results of a 32 nm hp L/S pattern EUV exposed using the small field exposure tool (SFET, inside our super clean room) on an NTD resist, at arbitrary units of development time (t00 to t08). From these results, it was found that almost no swelling behavior was observed in NTD resists during dissolution in organic solvent, in contrast to the large swelling confirmed in conventional positive tone resists developed at 0.26N aq. TMAH[2].

In the conference, detailed comparisons on the dissolution characteristics of NTD resists (at organic solvent developer) with typical positive tone resists (at 0.26N aq. TMAH developer) will be reported. Moreover, the effect of such dissolution characteristics on actual EUV lithographic patterning will be discussed.

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[1] T. Itani and J.J. Santillan, Appl. Phys. Express 3, 061601 (2010).
[2] J. J. Santillan and T. Itani, *submitted to* Jpn. J. Appl. Phys. (2012)
[3] S. Tarutani, H. Tsubaki, and S. Kamimura, *Proc.* SPIE 7273, 72730C (2009).

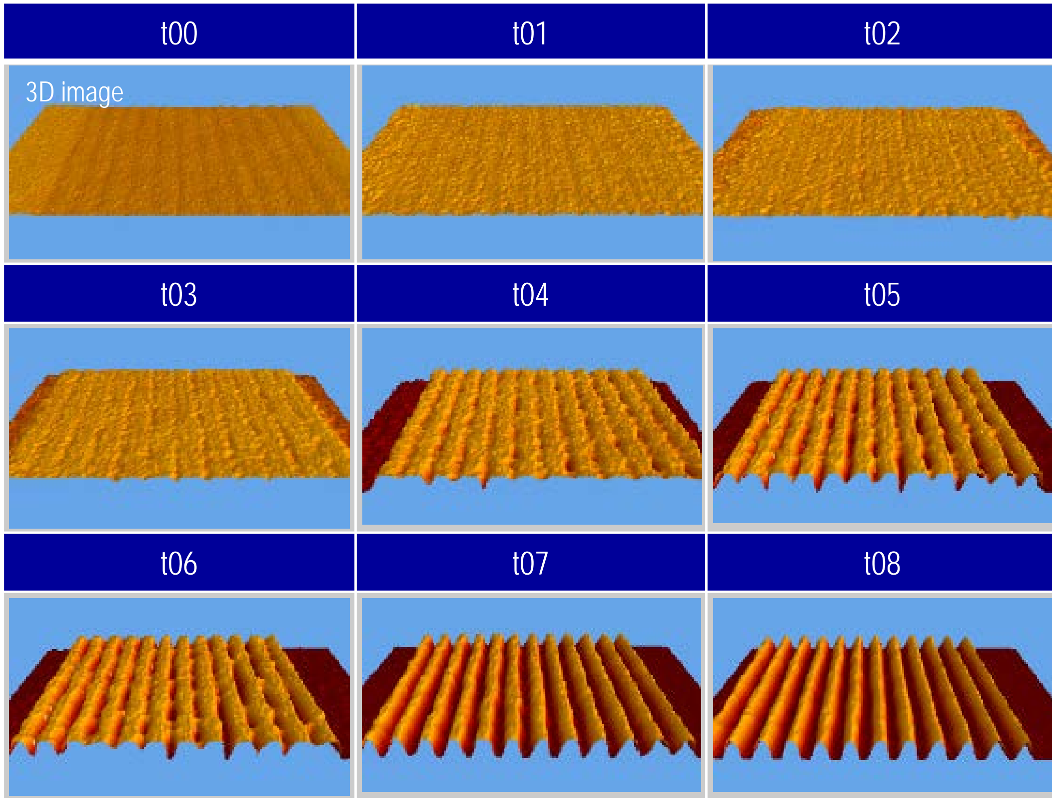

Fig. 1 The preliminary dissolution analysis results of a 32 nm hp L/S pattern EUV exposed using the SFET on an NTD resist, at arbitrary units of development time (t00 to t08).