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Optimizing Etching Conditions by Reinforcement Learning and Data Compensation Method

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To achieve nanoscale semiconductor-processing, the number of control parameters in etchers has increased. However, it has been difficult to optimize a recipe, that is an etching condition, with many parameters. Therefore, we proposed to explore optimal recipes for a target etching profile by AI. We present two exploring methods: one using reinforcement learning (RL) and the other using data compensation technique. They were developed to optimize recipes with multi-steps and recipes for fine patterns, respectively. We developed the method for multi-step etching by utilizing an in-situ optical monitor [1]. Applying RL to the monitor data, recipes can be optimized step by step. A vertical trench with a width of 750 nm and an aspect ratio (AR) of 4 was etched with predicted 5-step recipes. Next, we developed the method for fine pattern etching [2]. Nanoscale patterns are prone to collapse because of excessive side etching. To avoid the learning data shortage due to the collapse, missing data were compensated according to process knowledge. Applying supervised learning to the compensated data, a vertical trench with a width of 12.5 nm and an AR of 10 was etched with predicted recipes. [1] H. Nakada, et al., GEC2018, [2] H. Nakada, et al., DPS2019