Taking Up the Challenge to "Continue Efforts to Enhance Our Technology" and "Raise the Quality Levels of Our Products"

Aiming to Achieve Further Improvements in Semiconductor Performance, Essential in the Development of Cutting-Edge Equipment

The applications of semiconductors have expanded from personal computers and servers, to smartphones and tablets, as well as automobiles. There is an accelerating trend toward connecting the electronic equipment around us to the Internet. These include cloud-based data for health and medical equipment, and even vending machines with safety verification functions. The number of electronic equipment that is connected to the Internet is expected to increase from the current 5 billion units to 15 billion units in 2015. The TOK Group is therefore putting effort into developing businesses that can capture the new social needs, while at the same time merging the materials and equipment aspects with the cutting-edge technology that the TOK Group has built up over its years of experience, in a rational yet unique manner.

Development of Cutting-Edge Semiconductor Photoresist Technology

TOK's Double Patterning Technology

Technology that Contributes to Enhancing Productivity and Performance of Semiconductors

We are driving forward efforts to minimize the width of our circuits to the 20nm* class, so as to achieve improvements in productivity and performance for our semiconductors. In the production process of nm-class circuits, resolution is not possible even if we were to use ArF immersed exposure equipment. To resolve this issue, we have introduced a new technology known as "double patterning" (hereafter, "DP"). Until now, we have used a single exposure on one mask to create patterns. However, in DP, we use another mask in a double-exposure process. This new photolithography technology is drawing much attention.

DP technology enables microprocessing in the photolithography process. First, half of the target pattern is transcribed and processed. After that, the photolithography process is carried out again to create the remaining pattern.

There are several methods that can be used in DP technology. For instance, it is possible to repeat the usual process of photoresist coating ⟹ exposure ⟹ development⟹ etching, twice. A second method involves coating the pattern formed in the first photolithography process (photoresist coating ⟹ exposure ⟹ development) with a freezing agent, carrying out the second photolithography process before etching to create the other pattern, and then carrying out etching (thereby reducing the etching process by one time).

However, the application of the etching process twice, or the use of a freezing agent, may create problems by increasing costs or reducing work efficiency.

*1nm (nanometer) is 1 billionth part of 1m (meter).

Figure 1: Two patterns created in parallel to one another (side view)

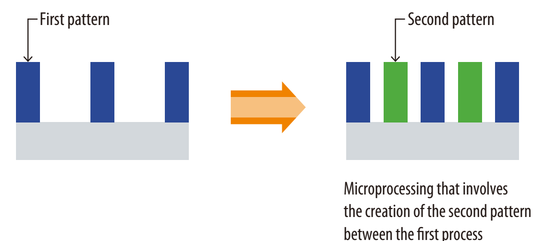
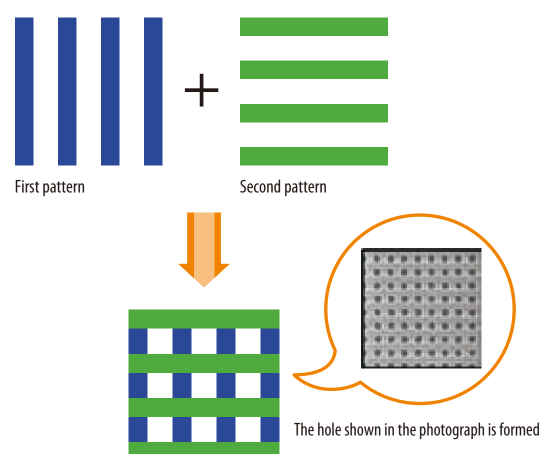


Figure 2: Crossing the two patterns (top view)

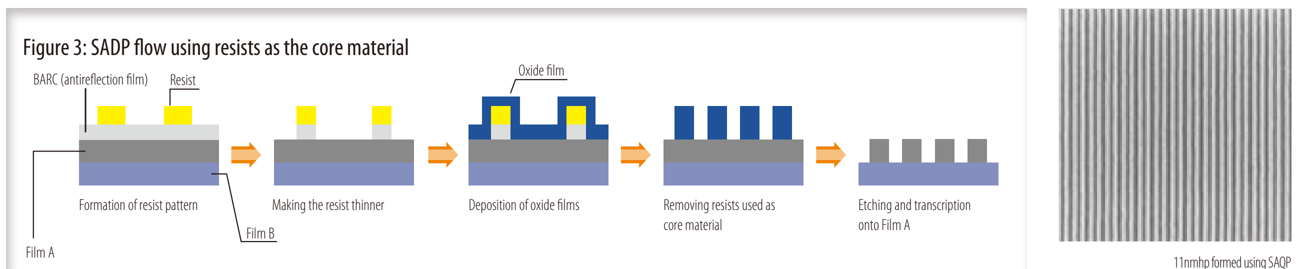


Toward the Creation of a New Process

As described earlier, the DP technology process is complicated, and may lead to a longer processing time. TOK has thus turned to the Spacer Aligned Double Patterning (SADP) technology, which is a form of DP technology, in order to streamline the process and reduce semiconductor manufacturing costs. We are currently engaged in joint research with Tokyo Electron Limited with the aim of formulating a new process that uses new resists as the core material.

This new process does not require the new addition of films for creating core patterns, since it uses resists as the core material. It is thus possible to achieve even greater miniaturization than the conventional single exposure method.

Furthermore, the creation of the Spacer Aligned Quadruple Patterning (SAQP) process also further advances microprocessing. By combining resists with the process, it contributes significantly to the formation of 11nm circuits.



11nmhp formed using SAQP

VOICE : Contribution to the Semiconductor Industry

My mission is to support the DP technology process in the manufacturing aspect

The development of resists necessarily involves design that takes into consideration properties that meet the needs of the customer, such as etching durability and roughness*. Of these, there are cases where we are given little information simply because the technology is so advanced. In these situations, we have to carry out the design process while predicting, to a certain extent, the needs of the customer. When our predictions correspond with the needs of the customer, and we receive praise and recognition for our efforts, I feel great joy in the thought of having created something together with the customer.

Currently, an important theme in SADP, which I am conducting research and development in, is that of streamlining the complicated DP technological process. Streamlining the process would contribute to greater production efficiency and cost reductions. Going forward, I hope to continue contributing to the further expansion and development of the semiconductor industry by providing support in the establishment of user processes from the manufacturing aspect.

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*Roughness: Refers to how rough the resist pattern is