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OPTIMIZATION OF SPIN-COATING PARAMETERS AND DEVELOPER EXPOSURE FOR AZ®P4620 PHOTORESIST

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INTRODUCTION

Photoresists[1] are polymers that change their solubility when exposed to UV light, allowing the selective removal of either exposed or unexposed regions by a chemical solution, called developer[2]. Photolithography is widely used in the fabrication of micro- and nano-scale structures on various types of substrates, such as silicon, glass, or polymers[3]. AZ®P4620 is a positive-tone photoresist that can be used for high resolution lithography because of its great aspect ratio, which is the ratio between the height and width of the structures[4]. This photoresist is suitable for applications such as microelectromechanical systems (MEMS), microfluidics, and microfabrication. However, the optimal parameters for using AZ®P4620 photoresist may vary depending on the design and the facilities process conditions. Therefore, this work aims to study and optimize the spin-coating parameters and developer exposure for AZ®P4620 photoresist in our cleanroom facilities.

OBJECTIVES

The objectives of this work are as follows:

- To characterize the influence of the various process variables (photoresist temperature, quantity, spin coating parameters) on the quality and thickness of the AZ®P4620 photoresist coating on a 2-inch silicon wafer.
- To find the optimal UV dose and development time for fabricating micro- and nano- structures while evaluating the process design limits when using AZ®P4620 photoresist.
- To optimize the quantity of developer and development time needed to process various lithography patterns on a standard 2-inch wafer using AZ®P4620 photoresist. .

METHODOLOGY

The methodology of this work consists of three experiments, each addressing one of the objectives. The experiments are as follows:

- **Experiment 1:** Study of AZ®P4620 photoresist thickness. This experiment measured the thickness of the photoresist coating using a DEKTAK profilometer after spin-coating, baking, and developing processes. The experiment varied the quantity of photoresist, spinning with and without a spread time, and temperature of the resist.
- **Experiment 2:** Adjustment of the parameters for lithography using AZ®P4620 photoresist. This experiment varied the dose, focus, and development time of the photoresist and observed the resulting structures using optical microscopy and DEKTAK measurements.
- **Experiment 3:** Characterization of AZ®400K development time for photolithography with AZ®P4620 photoresist. This experiment varied the quantity of developer, development time, developer re-use and temperature.

RESULTS

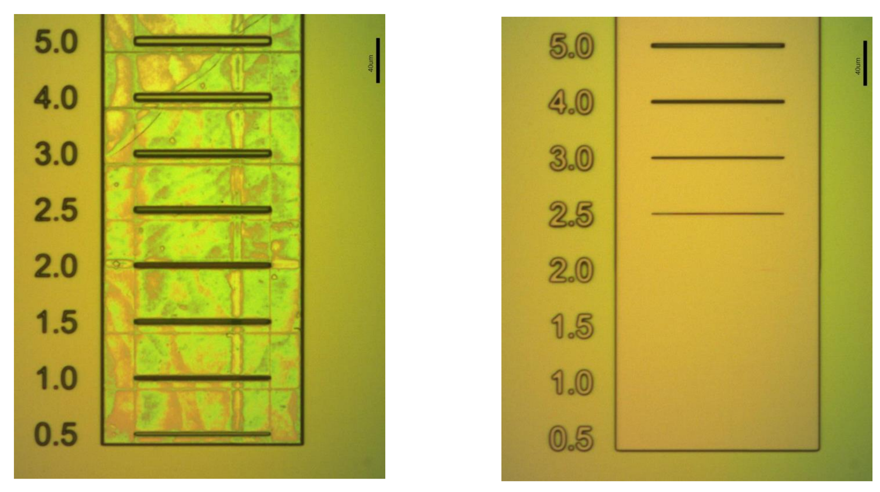

Figure 1-2
Comparison of a 100mJ dose vs 250 mJ dose. Linewidths of 2.0μm dissapear at this dose but resist sensitivitization is complete, hence showing complete development on the exposed photoresist.

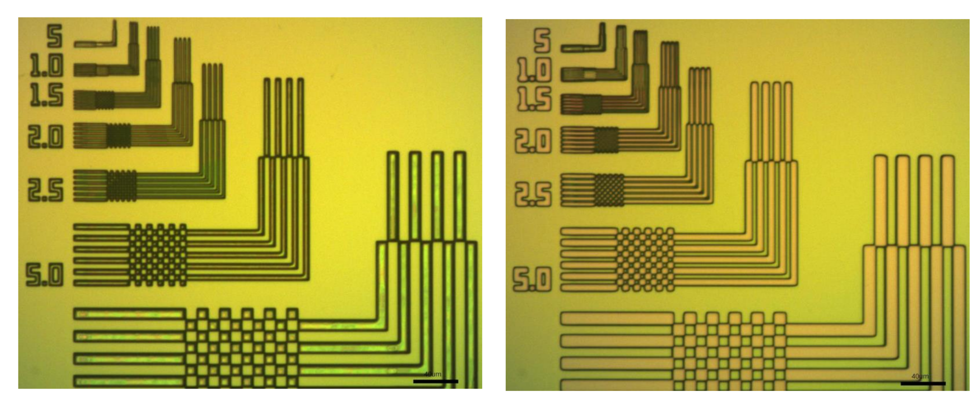

Figure 3-4
Comparison for a standard test pattern. Same as before only at 250mJ resist sensitivization is complete but patterns start to fade at linewidths of 5μm.

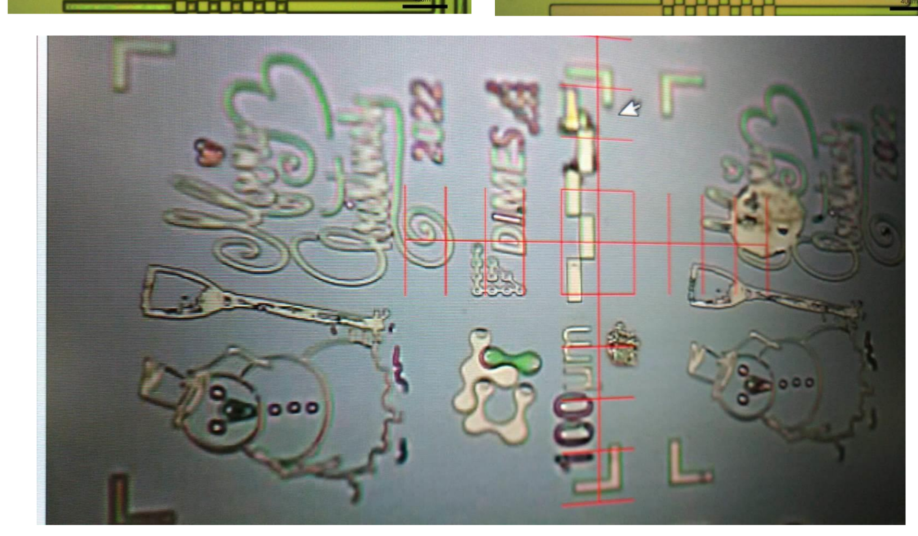

Figure 5
Image of a complex desing that was fabricated using the optimized lithography parameters from the previous experiments. It shows incomplete sensitvisation of the photoresist in certain areas of the design.

CONCLUSIONS

In this work, we have studied and optimized the spin-coating parameters and developer exposure for AZ®P4620 photoresist. We have found the optimal parameters for our cleanroom facilities and evaluated the process design limits. The main conclusions are as follows:

- The optimal parameters for lithography using AZ®P4620 photoresist spin-coated at 7000 rpm (avg. thickness of 5.5μm) are a dose of 250 mJ/cm^2 and a focus correction of 0μm. Additionally the optimal quantity of AZ®400K developer for a 2-inch silicon wafer is 25mL, which should be used for 5 minutes at 23ºC. The developer solution should be fresh and not reused or expired. The developer should be agitated gently and uniformly to avoid uneven development.
- The thickness of the AZ®P4620 photoresist coating can be mainly controlled by varying the spinning program. Lesser influence is noticed by adjusting the quantity of photoresist or the temperature of it; a spread step can improve the uniformity of the coating.
- When fabricating a more complex design using the optimized lithography parameters for our process, we found out that there are still reproducibility issues which have to be further studied. In consequence additional experiments to study the contrast curve of the photoresist have been carried out by other lab colleagues.

REFERENCES

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