Improving Front Side Process Uniformity by Back-Side Metallization

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Abstract

Plasma processes are an integral and important part of semiconductor device fabrication. The applications include the dry etching of metals, dielectrics, and semiconductors; chemical vapor deposition of thin films and oxygen plasma descum for organics removal. While each of these processes plays a critical role in the performance of the device, process uniformity across the wafer is crucial for consistent probe yield. If the plasma process condition varies drastically from the center of the wafer to the edge, device performance will change and probe yield will be affected. The critical parameters in a plasma process include temperature, gas flow, gas chemistries, pressure, and powers. Each of these parameters modifies the etching or deposition process characteristics. This paper demonstrates that overall process uniformity can be enhanced by metalizing the backside of the wafer. GaAs devices are fabricated on semi-insulating substrates with a bulk resistivity on the order of 1E8Ω-cm. The high resistivity of the substrate inhibits efficient coupling of RF power. This phenomenon is more pronounced at the front end of the wafer fabrication process where the metalized area is usually small. We will provide uniformity comparison with and without the back metal. We will also discuss how the improved uniformity translates into test parameters and yield gain.

INTRODUCTION

A uniform wafer map with perfect yield is the ultimate goal of every semiconductor fab. However, it is seldom the case in reality. Quite often, the wafer map would display a distinctive pattern that is caused by one, or a combination, of several processes. Micro-loading effect in a plasma-etch process has been studied and is known to cause local etch non-uniformity. A topic that has not been widely discussed is plasma-process uniformity on a macro scale. This paper examines the effect of RF coupling on plasma-process uniformity.

In a parallel-plate configuration, RF power is applied to one of the electrodes while the other electrode is electrically grounded. Figure 1 depicts a typical parallel plate reactive ion etch (RIE) system.

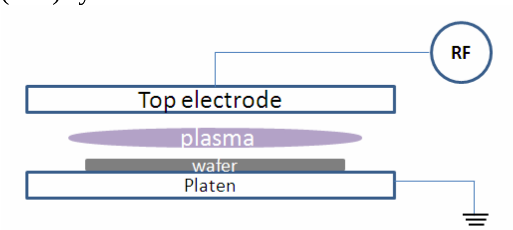

Figure 1 A typical parallel plate RIE system.

GaAs devices are built on a semi-insulating substrate with a bulk resistivity on the order of 1E8 Ohm-cm. The high resistivity that is necessary for device fabrication will also impede RF-power coupling. This can theoretically lead to non-uniform etching or deposition.

EXPERIMENT

To understand how RF power coupling may affect the uniformity of our processes, we had carried out a series of simple experiments. Four GaAs mechanical wafers were used for each group of experiment. Two of the wafers were sputtered with 1KA of W on the backside. The wafer rested on a special jig so that the front surface did not come into contact with the platen. The wafers then received our standard production 5KA nitride deposition in a PECVD tool, after which the nitride thickness was measured on a Nanospec 6100 reflectometer using a 25 point map recipe. The wafers were then put through a short nitride etch in a RIE tool. Standard-etch chemistry with SF_6 being the main etch gas was used for the experiment. The etch recipe was created to remove about 3500A of nitride so that there was enough nitride remaining on the wafer for mapping. The nitride thickness was measured again for thickness using the same 25-point recipe.

RESULTS

The two groups of wafer looked markedly different. The back-metalized wafer had a uniform purple color across the entire surface. The wafer without back metal had a pink stripe about 2" wide down the middle of the wafer. This was the imprint of the wafer handler of the nitride-deposition tool. The center of the wafer had four dots, which were the marks left by the lift-pins on the chuck of the etch tool. The edge of the wafer had color fringes that extended about one-half inch into the center. See Figure 2.

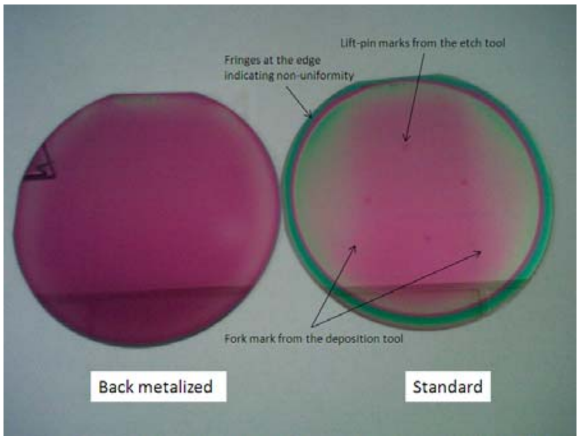

Figure 2 Comparison of back-metalized wafer and standard wafer after nitride etch

CONCLUSION

We will show that back-side metallization can improve front side process uniformity and demonstrate how we increased probe yield by improving plasma uniformity on a production mask. Furthermore, uniformity data of nitride deposition and nitride-etch process, with and without back metallization, will be presented.