ON Semiconductor

Deep trench module optimization for a more robust technology with reduced defect density at lower cost.

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Introduction and motivation.

Once a new technology is released to manufacturing, it still has numerous possibilities for improvement. Continuous defect density reduction is mandatory to fulfill customer's quality requirements. Technology marginalities need to be detected and solved to improve line yields and secure on time delivery. The production cost needs to be reduced so that the technology stays competitive. For a lot of projects these requirements are conflicting. We are presenting the results of a yield enhancement project on a 0.35μm mixed signal technology where we achieved a significant cost reduction as well as a more robust technology.

Description of approach and techniques.

Several years ago ON-semi developed a 0.35□m mixed signal high voltage technology using deep trench isolation to reduce the device area. The technology uses an innovative scheme that requires an Oxide Nitride Oxide (ONO) hard mask to protect the active areas during the trench isolation module. At the end of the trench isolation module the trenches are filled with poly. The planarization effect of a BARC layer coated on top of the deposited poly is used to obtain a sufficient flat surface after etch back in an Applied Materials Centura. The module is finalized by wet stripping the ONO mask.

The Centura used for etch back of the poly filler has a clamp ring with 8 fingers overlapping the wafer edge to ensure good contact of the wafer to the electrode. Although the clamp fingers are well within the 4mm edge exclusion used for this technology, the fingers locally disturb the plasma resulting in shadow effects that leave poly residues extending beyond the 4 mm area. The residues can not be removed by increasing the etch time as this results in too much recess of the poly filler.

A new process has been developed that has a slightly increased etch rate at the wafer edge preventing poly residues beyond the edge exclusion and keeping the poly recess in the trenches within the predefined limits. The introduction of the new process was combined with the replacement of the sacrificial BARC layer by a much cheaper resist layer. Although we were able to reduce the poly residues near the clamp fingers and to maintain the required planarization degree on the trenches, a first qualification attempt failed due to increased gate oxide defect density. The source of the gate oxide problem was investigated and solved by optimizing the thickness of the ONO hard mask layers. During the evaluation of the gate oxide problem we detected that the original process already contained this marginality and, if not discovered, could have resulted in a quality issue. The implemented solution is proven to have a decreased defect density, to be cheaper and resulting in a more robust technology.

Results/Conclusions/Perspectives.

With this project we have not only been able to improve the yield of this technology but also realized a cost reduction while making the technology more robust. Although the root cause of the gate oxide marginality is up to now not completely understood, it is in line with our experience that process steps on thin oxides prior to the gate module can have a negative effect on the gate oxide quality. Further investigation is ongoing to try to visualize and understand the cause of the gate oxide failures.