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Endpoint Detection in Semiconductor Etch Process Using OPM Sensor

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Etching is one of the most important steps in semiconductor manufacturing. In etch process control a critical task is to stop the etch process when the layer to be etched has been removed. If the etch process is allowed to continue beyond this time, the material gets over-etched and the lower layer is partially removed. On the other hand if the etch process is stopped too early, part of the layer to be etched still remains, called under-etched. Endpoint detection (EPD) is used to detect the most accurate time to stop the etch process in order to avoid over or under etch. The goal of this research is to develop a hardware and software system for EPD. The hardware consists of an Optical Plasma Monitor (OPM) sensor which is used to continuously monitor the plasma optical emission intensity during the etch process. The OPM software was developed to acquire and analyze the data to perform EPD. Our EPD algorithm is based on the following theory. As the etch process starts the plasma generated in the vacuum is added with the by-products from the etch reactions on the layer being etched. As the endpoint reaches and the layer gets completely removed the plasma constituents change gradually changing the optical intensity of the plasma. Although the change in optical intensity is not apparent, the difference in the plasma constituents when the endpoint has reached leaves a unique signature in the data gathered. Though not detectable in time domain, this signature could be obscured in the frequency spectrum of the data. By filtering and analysis of the changes in the frequency spectrum before and after the endpoint we could extract this signature. In order to do that, first, the EPD algorithm converts the time series signal into frequency domain. Next the noise in the frequency spectrum is removed to look for the useful frequency constituents of the data. Once these useful frequencies have been selected, they are monitored continuously in time and using a sub-algorithm the endpoint is detected when significant changes are observed in those signals. The experiment consisted of three kinds of etch processes; ashing, SiO_2 on Si etch and metal on Si etch to develop and evaluate the EPD system.

Keywords: EPD, in-situ monitoring, plasma process

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Improvement of Retention and Memory Window Characteristics by Crystallization in Hydrogenated Microcrystalline Silicon-germanium

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이번 연구는 system-on-panel에 적용하기 위한 비휘발성 메모리의 전하보유시간 및 메모리 윈도우 특성 향상에 관한 연구이다. 이를 위해 SiO2/SiOX/SiOXNY의 메모리 구조를 이용하였으며, 채널층으로 결정화 온도에 따른 수소화된 미세결정 실리콘-게르마늄을 이용하였다. 채널 층으로 사용된 수소화된 미세결정 실리콘-게르마늄은 비정질 실리콘-게르마늄보다 더 낮은 bandgap과 더 적은 defect density로 인하여 더 향상된 전하보유시간 및 메모리 윈도우를 얻을 수 있었다. 결정화가 거의 이루어지지 않은 실리콘-게르마늄 비휘발성 메모리의 경우 약 4.9V의 메모리 윈도우를 얻을 수 있었다. 반면 300oC에서 약 43.4%의 결정화가 이루어진 실리콘-게르마늄의 메모리 윈도우는 약 5.9V로 약 17%의 향상이 있으며, 10년 후 74.5%의 높은 전하보유시간을 가졌다.

Keywords: 비휘발성 메모리, 수소화된 미세결정 실리콘-게르마늄, 전하보유시간, 메모리 윈도우