abstract

This research emphasizes the use of low energy and low temperature post processing to improve the performance and lifetime of thin films and thin film transistors, by applying the fundamentals of interaction of materials with conductive heating and electromagnetic radiation. Single frequency microwave anneal is used to rapidly recrystallize the damage induced during ion implantation in Si substrates. Volumetric heating of the sample in the presence of the microwave field facilitates quick absorption of radiation to promote recrystallization at the amorphous-crystalline interface, apart from electrical activation of the dopants due to relocation to the substitutional sites. Structural and electrical characterization confirm recrystallization of heavily implanted Si within 40 seconds anneal time with minimum dopant diffusion compared to rapid thermal annealed samples. The use of microwave anneal to improve performance of multilayer thin film devices, e.g. thin film transistors (TFTs) requires extensive study of interaction of individual layers with electromagnetic radiation.

This issue has been addressed by developing detailed understanding of thin films and interfaces in TFTs by studying reliability and failure mechanisms upon extensive stress test. Electrical and ambient stresses such as illumination, thermal, and combined practical stresses are inflicted on the mixed oxide based thin film transistors, which are explored due to high mobilities of the mixed oxide (indium zinc oxide, indium gallium zinc oxide) channel layer material. Semiconductor parameter analyzer is employed to extract transfer characteristics, useful to derive mobility, subthreshold, and threshold voltage parameters of the transistors. Low temperature post processing anneals compatible with polymer substrates are performed in several ambients (oxygen, forming gas and vacuum) at 150 °C as a preliminary step. The analysis of the results pre and post low temperature anneals using device physics fundamentals assists in categorizing defects leading to failure/degradation as: oxygen vacancies, thermally activated defects within the bandgap, channel-dielectric interface defects, and acceptor-like or donor-like trap states. Microwave anneal has been confirmed to enhance the quality of thin films, however future work entails extending the use of electromagnetic radiation in controlled ambient to facilitate quick post fabrication anneal to improve the functionality and lifetime of these low temperature fabricated TFTs.