

Final Report Summary

Measurement and Characterisation of ultra-thin Organic Films



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Background

Point 35 microstructures customize existing semiconductor equipment and use the resulting profits to fund the development of their own deposition equipment through the trade name MEMSSTAR. The Memstar SPD system (Surface Preparation and Deposition) deposits various organic films and is aimed primarily at the MEMS and BioMEMS markets. Many of these films are self-assembled monolayers (SAMs), which are only one molecule thick. The films are deposited onto samples and silicon wafers of up to 200mm in diameter to impart specific surface functionality, e.g. a highly hydrophobic surfaces, anti-stiction coatings and biocompatible coatings.

The Thin Film Centre at the University of the West of Scotland (formerly University of Paisley) has extensive experience of thin film deposition and of characterisation using methods such as spectroscopic ellipsometry, contact angle and atomic force microscopy.

Scope of Project

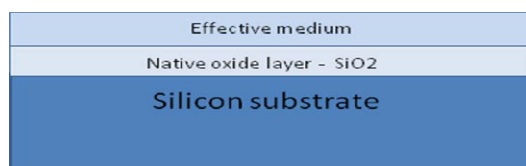
This was a feasibility study into the characterisation of Memstar's ultra-thin films by spectroscopic ellipsometry, contact angle and atomic force microscopy. The objectives were to investigate the effect of process parameters on thickness, roughness and hydrophobicity of the deposited films.

Results

Memstar deposited a series of self-assembled monolayers (SAM) on 1cm squares cut from a silicon wafer. 50 samples were used in a Design of Experiments trial.

Spectroscopic Ellipsometry

After some trials, a suitable model based on the Bruggeman effective medium model was successfully used to fit the ultra-thin films by spectroscopic ellipsometry at the Thin Film Centre. The final model is shown below.



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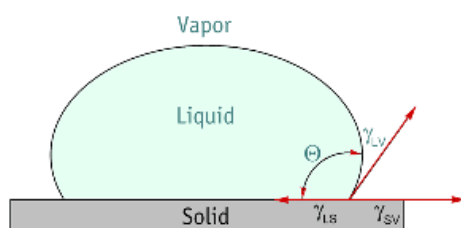


It was shown that the films were rough on the nanoscale with average thicknesses of significantly less than one nanometre and these results were confirmed by atomic force microscopy.

Water Contact Angle

Hydrophobicity was investigated by contact angle measurements using ultra-pure water.

The contact angle θ , is the angle at which a liquid or vapour meets a solid surface. It is therefore a measure of how well a liquid is said to wet a solid at an interface. The angle, Θ , is formed at a three phase boundary interface between a solid, liquid and a gas and is shown below.



A video camera system was used to capture the image of a small drop of water on the wafer surface and a sophisticated model used to fit the drop shape in order to extract an accurate value for the contact angle. Although values were high for all samples, indicating that film deposition led to hydrophobic surfaces, significant variation in the contact angle was found.

Conclusions

The films could be “seen” by spectroscopic ellipsometry and the data could be fitted to a Bruggeman effective medium model.

Film thicknesses were of the order of a few Angstroms.

The films showed nanoscale roughness.

The higher the chamber pressure the higher the contact angle.

The lower the organic material carrier gas flow the higher the contact angle.

The higher the H₂O flow the higher the contact angle.

From the ellipsometry work and the associated model it is now possible to quantify the continuity and the thickness of the deposited film. It is widely accepted that the robustness of the film, especially in harsh environments is related to how continuous the film is deposited. Being able to measure the film and determine this value is crucial when developing a coating for various applications and environments.

The TTOM has allowed this work to be initiated and the relationship between Point35 Microstructures/Memsstar and the Thin Film Centre to develop. Further work would allow various deposition set-ups to be investigated for the current film. Also, this work can be applied to the various organic films that can be deposited using the memsstar® SPD system.

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