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The Preparation of ACEL Thin Films

by

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MOCVD THIN FILMS FOR ACTFEL DEVICES

1.0 Introduction

In line with the USAC request for test samples to make a preliminary assessment of the potential of the CVD thin films, the programme emphasis has shifted toward an effective survey of various insulator - ZnS.Mn thin film combinations.

2.0 The Present Position

The LPMOCVD system is now fully operational in the horzontal substrate mode. Slight modifications to the bleed gas input line have been made to improve control and stability, but some pressure drift (few torr) is still apparent during the course of a deposition run. This appears to be due to small variations in pumping conditions as a result of imcomplete waste vapour trapping. Further modifications will be carried out to rectify this situation, however, the system now has sufficient reproducibility to deposit ZnS.Mn TF for initial device fabrication and assessment. Manganese dopant control is adequate and is being carried out by the reduced pressure volatilization of a 25% solution of TCM (tricarbonyl methyl cyclopentadiene manganese) in dekalin. ZnS.Mn TF showing high photoluminescent brightness and uniformity are now being achieved.

The ASP system has proven to be an exceptionally good technique for oxide TF deposition. Uniform, clean, transparent films can be produced with relative ease. Thin films of zirconium oxide (ZrO_2), aluminium oxide (Al_2O_3) and lead titanate ($PbTiO_3$) have now been produced. Low cost source materials such as zirconium and aluminium acetylacetonates and alkoxides have proven to be very effective, although a reduction in deposition temperatures (currently 400–450° C) would be beneficial to minimise interfacial effects. In the case of the alkoxide source materials, these may be employed in a single reactor operation to build up the insulator–ZnS.Mn–insulator stack. This maybe an advantage. The $PbTiO_3$ TF are found to be amorphous at deposition temperatures up to ~400° C. $PbTiO_3$ becomes noticeably darker when ZnS.Mn is deposited it under reduced pressure at 400° C indicating a possible compositional change in the $PbTiO_3$. In addition, the PL intensity is markedly reduced compared to that of ZnS.Mn TF on ZrO_2 or Al_2O_3.

A few complete ITO–ZrO_2–ZnS.Mn–ZrO_2 stacks have been prepared for evaluation by the USAC. In this case, the final ZrO_2 layer is held at temperature in an inert atmosphere prior to deposition of the top ZrO_2 layer in the ASP system. A ZnS.Mn TF has been deposited onto an ITO–insulating layer suppied by the USAC. The film appears to be 'cloudy' with some apparent surface defects, however, the as–supplied film had many noticeable defects and our deposition process may be accentuating these. A film grown on ITO during the same run was apparently relatively free of macroscopic defects. This has been included in the deliverables.

3.0 Summary

We believe our novel approach to EL panel fabriction has much to commend it and that there is a clear potential for the fabrication of stable, high efficiency, high brightness devices. Moreover, the deposition systems being employed have considerable flexibility in terms of evaluating new ZnS.Mn–insulator combinations with relatively short development times required

for each new system. Other deposition technologies have considerably more difficulty in developing new systems. This in itself is an extremely valuable asset and should not be overlooked. Finally, it should be mentioned that CVD is likely to be a reasonably low cost option for volume production and this is clearly an important factor to consider.

Having demonstrated in a preliminary manner, the copability of the CVD option, we believe it to be imperative that there is 1-2 years contractual stability in order to determine and fully characterise the optimum ACTFEL system. The current 3 monthly contract system is a rather poor platform for planning and carrying out the type of detailed research programme required to fully utilise our resources. In addition, it would be more efficient if we were to de-emphasise the deliverables aspect of the programme such that good test panels are supplied as they are produced rather than the current overly rigid bi-monthly quota. In essence, the longer term programme should be re-prioretised in the following manner:

1. Continue deposition work on current systems but with much more emphasis on systems control and analysis of the reactors and thin films.

2. Investigation of multiple vertically stacked substrate reactor to fully evaluate its potential for eventual scale-up to volume production.

3. An expansion of our AC device fabrication and testing facilities to investigate factors controlling stability, efficiency and brightness.

Overall, we believe that it is now of critical importance that we carry out a research programme that will significantly add to our knowledge of materials selection and control for optimum ACTFEL device characteristics.

If required, a more detailed research plan based on a further 1-2 years programme will be submitted.

Finally, we believe that it is essential that we develop good lines of communication between USAC research scientists and those at Thames, with frequent thin film and data exchange and perhaps some opportunity for research staff to discuss results and progress at least on an annual basis.