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Sustainable Ultrasonic Electroless and Immersion Plating Processes for Photovoltaic and Printed Circuit Board Manufacture

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The UK and governments Worldwide have highlighted the need for renewable energy sources to alleviate global warming, ensure energy security and meet rising energy demands. There is therefore a huge potential global market for photovoltaic's (PVs) but they must be cost effective and efficient. Electroless and immersion plating processes are critical steps in the PV manufacturing process but are characterised by high temperature operation and long plating times which adversely affects manufacturing costs. Similar issues affect the Printed Circuit Board (PCB) industry which is dominated by SMEs in the UK and EU who are competing with the low labour cost economies of the World.

This research project will investigate the use of ultrasound in electroless and immersion plating processes to reduce temperatures and plating times, eliminate the utilization of hazardous reducing agents and lower water consumption. Applying ultrasound to an aqueous solution will induce a number of effects which are useful in electrochemical processes. Ultrasound can create cavitation bubbles which on collapse will produce localised high temperatures and pressures. Electroless and immersion plating processes can require temperatures as high as 90 ^{o}C to produce acceptable plating rates. By applying ultrasound at the surface to be plated, localised high temperatures and pressures can be generated even though the bulk solution temperature might have been reduced. In addition, ultrasound can raise the plating rates of these processes by increasing the transport of metal ions to the substrate being plated and by reducing the thickness of the boundary layer which these ions have to cross. These effects should therefore negate the reduction in plating rates caused by lowering the temperature of the plating solution. An essential ingredient in an electroless plating solution is the 'reducing agent' which must be present for plating to occur. Unfortunately the reducing agents which give the highest plating rates also tend to be hazardous (e.g. formaldehyde).

Abstract

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Once again by using ultrasound to enhance the plating rates of the electroless process a wider range of reducing agents could be used which are less hazardous. One of the problems when using ultrasound in electroless processes is that it can destabilize the solution chemistry. To alleviate this issue the study will investigate the use of higher ultrasonic frequencies because these produce less aggressive effects than conventional 20 or 40 kHz. The use of pulsed rather than continuous ultrasound, applied for a few milliseconds or up to several seconds over the plating time will also reduce the chances of destabilising the plating solution. Ultrasound is also known to produce a more fine grained deposit which could reduce the porosity of the plated layer, thus increasing the efficiency of PVs and improving their corrosion resistance.

There are several innovative and novel aspects to this project;

- The use of ultrasound to reduce process temperatures for electroless and immersion plating processes
- Investigating the effect of ultrasound on precious metal immersion plating
- The use of ultrasound to enable the use of less hazardous reducing agents
- The effect of pulsed ultrasound on electroless and immersion plating
- The effect of ultrasound on the grain structure of immersion deposits

The consortium is composed of key representatives and end-users from the PV and PCB industries whilst the Sonochemistry Centre has World leading expertise in ultrasonic research. In addition, the consortium includes international academic specialists who are recognised leaders in the fields of sonochemistry, electrochemistry and surface analysis. The project also aims to create an 'Early Adopters Forum' which will be a group of companies given priority information on the progress of the project. It is hoped that by the end of the research programme this will produce a ready-made market for the low temperature processes developed.