



The Evaluation of Sonochemical Techniques for Sustainable Surface Modification in Electronic Manufacturing

Andy Cobley, The Sonochemistry Centre at Coventry University

The electronics industry has always had a requirement for the surface modification, adhesion promotion and cleaning of a vast array of di-electric substrates and with the emergence of printed electronics the choice of substrate will increase still further as, theoretically, anything that can be printed could become an electronic device. The surface modification of polymers and plastics is important in the traditional manufacture of PCBs (i.e. the desmear process) and Moulded Interconnect Devices (MIDs), but will become even more so for polymer electronics, printed electronics, Radio Frequency Identification (RFID) technology etc. The metallization of glass and ceramics is also becoming of interest for the manufacture of optical circuits and for various displays. Achieving good adhesion between such substrates and the conductive tracks (whether a metal, semiconductor, conductive ink, polymer or paste) is perhaps the most critical stage of the manufacturing process since if the adhesion is poor the device will simply fail. Traditional 'wet' manufacturing techniques for surface modification are used currently for high volume manufacturing but suffer from the drawbacks that they utilize hazardous chemistry, operate at high temperatures and require copious rinsing. In addition many of the 'advanced' materials (e.g. high Tg laminates, ceramics etc) used in electronic manufacturing also tend to be more chemically inert, requiring even more aggressive chemistry and, as a result, traditional chemical methods often cannot be used to process them. This IeMRC funded research programme addresses these issues by evaluating sonochemical surface modification techniques with the ultimate objective of producing a one step process using benign chemistry at lower temperature with less rinsing. Four core materials have been chosen as representative of the variety employed in electronic manufacture, namely Isola 370HR (a high Tg FR4 type laminate used in PCB manufacture), a ceramic, Noryl HM4025 (a PPE/PS polymer utilized in MID production), Cycolac S705 (an ABS/PC polymer employed in a variety of electronic equipment). Early work demonstrated that significant surface modification of these materials could be achieved by applying low frequency (20 kHz) ultrasound through water (see Figures 1 (a) and (b) below).

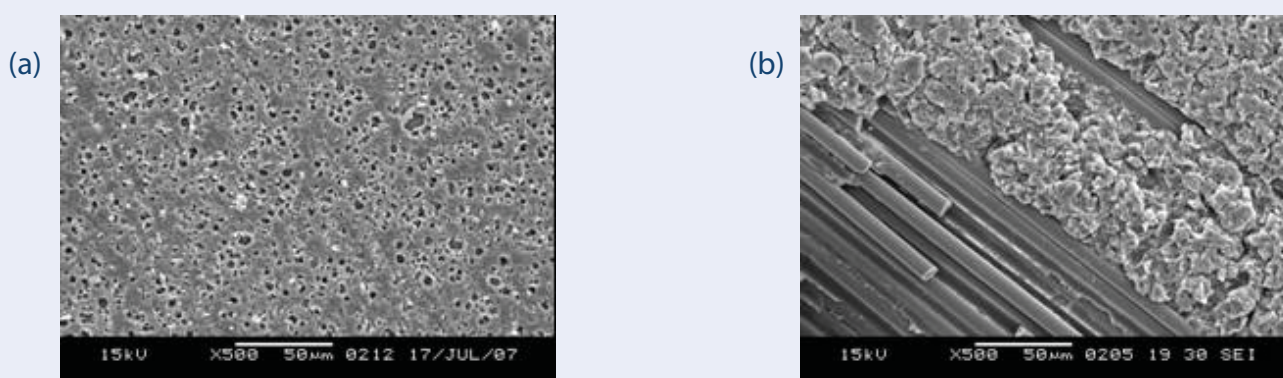


Figure 1. Surface of Isola 370HR (X 500 magnification) (a) as received (b) after 30 minutes sonication at 20 kHz in water



Standard Project

This remarkable result was rigorously pursued in subsequent work and the factors affecting the process were investigated. It was found that ultrasonic frequency, added surfactant and a reduction in the process temperature would all significantly affect the process whilst sample preparation was also important. One of the most difficult materials to surface modify using ultrasound was found to be ABS but, by screening a range of chemical additives (at ppm levels), we have been able to optimise some of these parameters in order to bring about significant changes in the surface of this material. Indeed, the consortium is now seeking patent protection for this work.

The study to date has clearly demonstrated that sonochemical surface modification can bring about physical changes to the surface of the material due to the impact of 'microjets'. Work has recently been carried out to find out whether such physical changes are also accompanied by chemical changes to the surface. This aspect of the project is being pursued in collaboration with the universities of Loughborough and Cardiff.

Using commercially available equipment (the Prosonitron reactor from our ultrasonic partner Prosonix) a trial of the sonochemical process was performed at the premises of one of the members of the consortium and preliminary results suggested that scale-up was feasible. In addition, one of the 'spin-off' projects carried out with Con-part AS in Norway has clearly demonstrated that sonochemical surface modification of polymer spheres can lead to significant improvements in their subsequent electroless copper metallization.

In the two-and-a-half years since this project started the feasibility of the ultrasonic surface modification of a range of materials in liquids as benign as water has been achieved. The factors affecting the process have been established and patentable work has been identified. The possibility of scale-up has been demonstrated within the consortium whilst work with another commercial company has illustrated that sonochemical surface modification may be of wider value for the promotion of adhesion for subsequent coatings.