The research aimed to improve a prototype manufactured under the previously iLeMRC feasibility study. The device is a variable frequency microwave heating oven used for encapsulation, underfills and small density interconnects. The equipment performed the RF-cure at high frequency for ICA bumps of tens of micron size and/or the cure at low frequency of encapsulants. The installation of this oven will be on the arm of a high precision placement machine for micron accuracy alignment capability and the RF-cure of underfills. Following many prototypes created for this oven, an optimum design has been selected and curing of paste materials has taken place. Closed feedback control of the heat dissipated (and the input power to be applied) was achieved using a thermal camera. Work is carried out to look at the impedance spectrum of various paste materials at different temperatures. The work of microwave curing of paste materials seems to indicate that the traditional curing models cannot be used readily for this application.

The prototype (fig. 1) of the 'open-ended' oven comprises a dielectric filled rectangular waveguide having a short circuit at the excitation end of the waveguide shown of the left of the photograph and an open circuit at the opposite end shown in the centre, such that the target package to which heat is to be applied, can be placed easily within the evanescent fields adjacent to the dielectric interface. The prototype has been specifically designed to provide a demonstration of the formation of multiple 'hot-spots' in the open-end (fig. 2). At a lower frequency of excitation, the oven can also be used to cure uniformly paste materials such as encapsulants.
The project demonstrated that a set of process conditions can be achieved so that variable frequency microwave heating and cure technology can be implemented successfully into electronic component manufacture, assembly and packaging. The optimum set of parameters for RF-curing is been looked at in collaboration between the two Universities and the industrial partners (Henkel Multicore, Bookham, Renishaw, MCE and NPL). This project enables the creation of a unique, patentable RF-cure apparatus for insertion into a novel bonding equipment that will permit a more efficient packaging technology.

The project has reached level 3 on the TRL scale. It is now continuing as a European Project with Heriot-Watt University, the University of Greenwich, the Fraunhofer Institute IPA (Stuttgart, Germany), and the EEI (Estonia) acting as Research and Technology Performers on behalf of a series of European Associations of SMEs.

Contact Details:
Prof. Marc Desmulliez, Heriot-Watt University, MicroSystems Engineering Centre
School of Engineering & Physical Sciences Earl Mountbatten Building Edinburgh, EH14 4AS, Scotland, UK
Tel: +44 (0)131 451 3340, Email: m.desmulliez@hw.ac.uk

Paper Publications during the iElecMRC project


Feasibility Project

Frequency Agile Microwave Bonding System (FAMOBS)

Sangster, A.J., Sinclair, K.I., Desmulliez, M.P.Y.

The research aimed to manufacture a proof-of-concept device for variable frequency microwave heating. For the purpose of the feasibility study, the equipment performed only the RF-cure at high frequency for ICA bumps of micron size and/or the cure at low frequency of encapsulants. The installation of this oven on the arm of a flip-chip bonding machine for micron accuracy alignment capability and the RF-cure of underfills were postponed until the full proposal stage. The feasibility study proved that, in principle, a micro-engineered microwave oven can be fabricated.

The proof-of-concept prototype of the ‘open-ended’ oven comprises a dielectric filled rectangular waveguide having a short circuit at the excitation end of the waveguide shown of the left of the photograph and an open circuit at the opposite end shown in the centre, such that the target package to which heat is to be applied, can be placed easily within the evanescent fields adjacent to the dielectric interface. The prototype has been specifically designed to provide a demonstration of the formation of multiple ‘hot-spots’ in the open-end (fig. 1). At a lower frequency of excitation, the oven can also be used to cure uniformly paste materials such as encapsulants.

Fig. 1  Total E-field pattern at the interface for a TM_{3,3,1} mode within a quarter section of the cavity.

The project demonstrated that a set of process conditions can be achieved so that variable frequency microwave heating and cure technology can be implemented successfully into electronic component manufacture, assembly and packaging. No attempt was made to fully characterize the optimum set of parameters for RF-curing. This project enabled the creation of a unique, patentable RF-cure apparatus for insertion into a novel bonding equipment that will permit a more efficient packaging technology.

Contact Details
Prof. Marc Desmulliez
CEng, MInstP, CPhys, MIEE
Heriot-Watt University
MicroSystems Engineering Centre
School of Engineering & Physical Sciences Earl Mountbatten Building Edinburgh, EH14 4AS, Scotland, UK
Tel: +44 (0)131 451 3340
Fax: +44 (0)131 451 4155
Sec: +44(0)131 451 4165
Email: m.desmulliez@hw.ac.uk

Website link: http://www.cee.hw.ac.uk/misec/