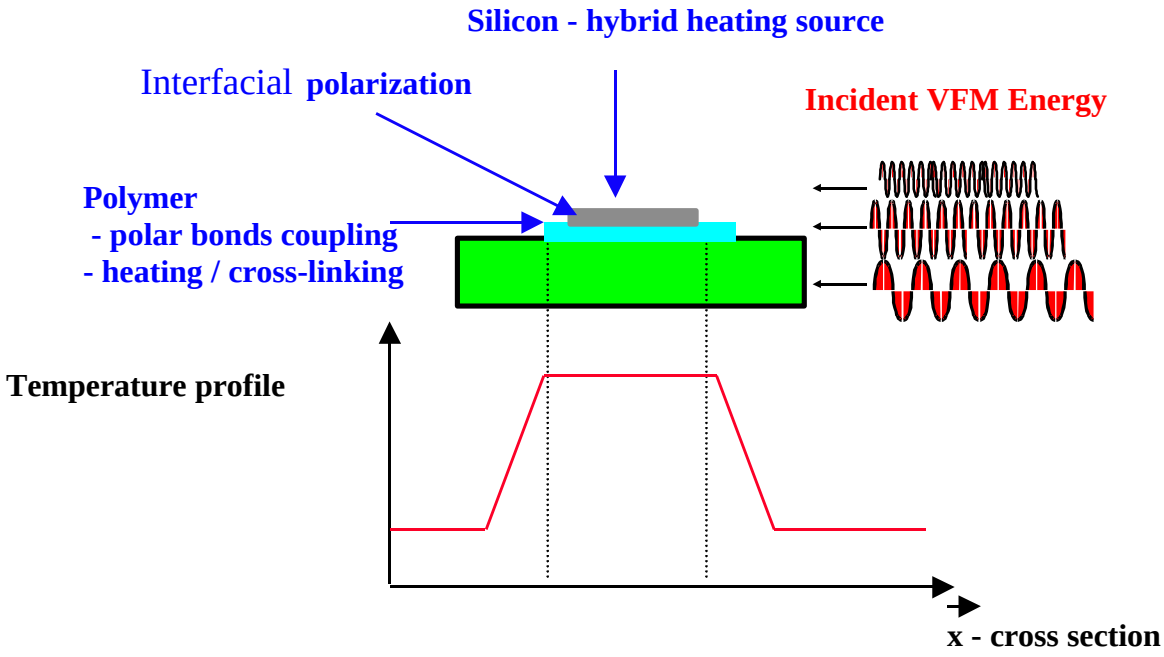
**MicroCure™ – VFM**
***rapid cure processing***

# ***Application Note***

MC 98 – 201

*Subject:* **Flip Chip Underfill Cure**
**Dexter FP4527**

***VFM Background:*** VFM processing is a controlled approach to uniform distribution and selective heating with microwave energy. The technique was developed for the purpose of processing many of today's advanced materials, with particular applications in the area of polymer adhesives and encapuslants used in electronic packaging. VFM provides rapid heating at the molecular level, hence is volumetric, and is distributed uniformly throughout the material by sweeping across a wide frequency spectrum. In addition, by sweeping through the complete variable frequency range in tenths of a second, the process eliminates any conditions that would create arcing or damage to metallic components or circuitry. Furthermore, VFM heating is inherently selective and, as a result, the heating of an encapsulant material to cure temperature is often accomplished without raising the substrate temperature to anywhere near the same level.



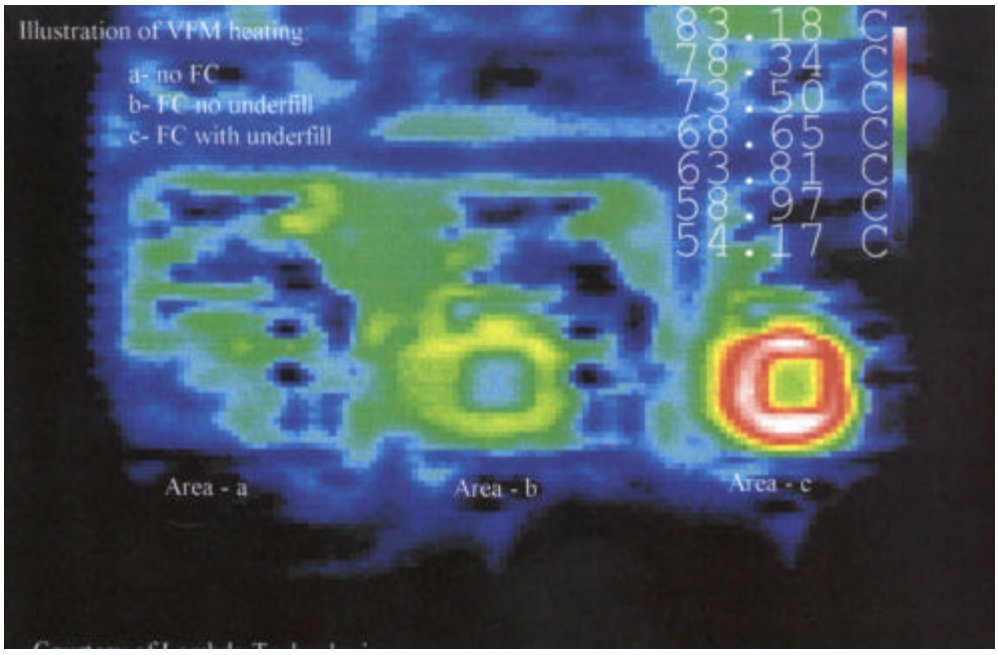
***The Flip Chip Underfill Process:*** The demand for lighter, faster, smaller and less expensive products has led the electronics manufacturing industry to the use of new packaging techniques such as Flip Chip technology. In most cases, implementation of Flip Chip design requires the use of a liquid encapsulant as an underfill between the chip and the substrate. The underfill provides protection as well as a compliant interface for the difference in CTE between the substrate and the chip. However, these advanced polymeric materials have cure times of cure times ranging from 30 minutes to 2 hours at temperatures of 150 to 165ºC. This cure process has created problems in manufacture, related to production throughput, factory space, inventory levels, quality control, and overall stress on the die. VFM has been successfully demonstrated as an alternative to conventional oven methods to address all these critical factors.

***VFM Application Results:*** The table below summarizes the VFM results of trials using Hysol® 4527 underfill Detail description of process trials, along with suggested cycle profiles when using this material also follow.

| | **Conventional** | **VFM** |
|---|---|---|
| **Cure cycle time/temp** | 30 minutes @ 165ºC | 2 minutes @ 120ºC<br>2 minutes @ 155ºC |
| **Tg Properties (1)** | 148ºC | 148ºC |
| **Adhesion Properties (2)** | 100 % | 100% |
| **Radius of Curvature (3)** | 649 mm | 987 mm |

(1) Average of readings as measured by DSC, after cure
(2) Average of shear tests comparing force required to push-off the 10mm x 10mm die
(3) Measured by CyberScan instrument to evaluate stress on the die after cure (10mm die)

The temperature profile conditions with VFM provide for inherent selectivity of heating. This is demonstrated by the IR thermal image taken of a 3-up portion of a flip-chip assembly on FR-4 board after coming out of the VFM curing system. This circuit consists of one flip chip die at each circuit. However, in location 1, the die was not placed, in circuit 2, the die was placed but not underfilled, and in location number 3, the die placement included underfill material. As noted, the VFM energy is focused on the underfill material, without heating the substrate and, therefore, permits the potential for the significant reduction in the level of stress build up (as measured by radius of curvature) on the die.



***Functionality & Reliability Testing:*** Test coupons used in the above trials were daisy chain type circuit boards. The assemblies were subjected to functionality and reliability test cycles that included thermal shock and THB procedures. A sample quantity of assemblies successfully passed thermal cycling tests, up to 1,000 cycles.

The circuit assemblies used in the above trials were primarily FR-4 substrates. The maximum benefit of VFM's selective heating is available with the organic packaging assemblies. However, trials of the Hysol underfill material has also included ceramic and flexible circuits (e.g. polyimide), with similar cycle time, adhesion, and functionality test results. In fact, testing by an end user of the flexible circuit configuration, included JEDEC Level 4 criteria, which resulted in a full **acceptance of the VFM process cycle for production qualification**.

***VFM System Configuration:*** The VFM system used for the above trials was a standard MicroCure 5100, in-line, 700 watt model. This system is a fully automatic package, including SMEMA compatible interface. A cycle time of 5 - 6 minutes would be nominal for processing up to six pallets of multiple-up circuits, using approximately 400 watts of total VFM power output.