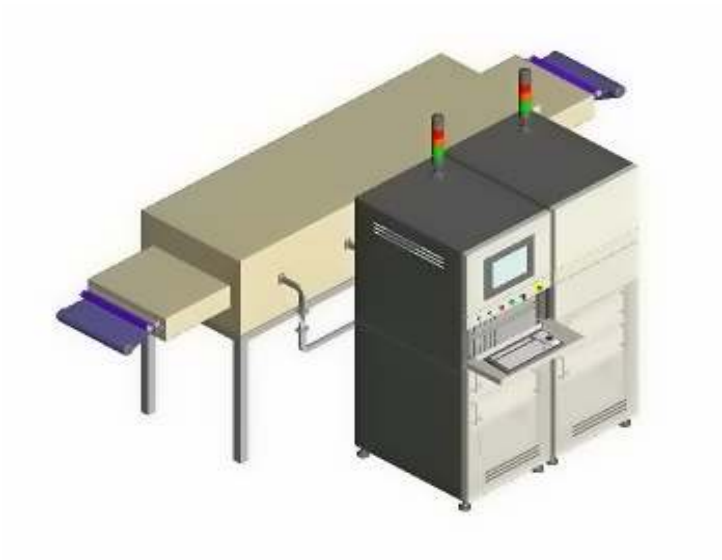
Microwave solutions for the next generation in advanced mate

VFM TECHNICAL BULLETIN 7

VFM Processing & Hybrid Heating Alternatives



Background

Variable Frequency Microwave processing leads to rapid curing of adhesive materials. The enhanced cure times are due to the ability of the oscillating electric field to polarize molecules and force a rotational movement that is additive to the normal thermal agitations. The magnitude of these added thermal agitations depends on the level of polarity of the adhesive (i.e., the Debye moment). The higher the Debye moment, the higher the contribution of the microwave field to the local temperature of the molecules. The extra increase of temperature brought about by microwave energy at the molecular sites responsible for cross-linking, lead to a macroscopic and observable faster cure. The mechanism behind faster microwave curing is thermal in nature and therefore is of limited impact on the resulting properties.

Discussion

When electronic assemblies, which can typically are composed of various subassemblies, are exposed to VFM electromagnetic fields, they heat differently than in convection ovens. In a convection oven, the thermal environment around an electronic assembly dictates the thermal energy and temperature that, in time, the assembly will reach. In VFM, the energy is dissipated volumetrically in the materials with the highest loss factor. It is for this reason that silicon, adhesive and some metal traces will heat. In VFM heating, the assembly is in a non-thermodynamic equilibrium. That is, the energy input is selectively converted into heat into the subassemblies and the accumulated heat is subsequently flowing to colder areas within the subassemblies and to the room temperature environment. The selective heating in combination with rapid curing in the

VFM case is typically beneficial. Two pronounced VFM process benefits are: 1- an overall reduced thermal budget and 2- overall reduced thermo-mechanical stresses.

At times, the VFM selective heating leads to the utilization of high VFM incident power to execute a given process recipe. Furthermore, the total VFM process cycle time may be impacted because of slow ramp rates in some cases. These special cases are typically encountered when the electronic assemblies are made with large metallic heat sinks and are handled using large metallic carriers. In order to circumvent this issue, a hybrid heating approach is taken to provide a thermal environment that is higher than room temperature. This hybrid heating approach is adopted on an as needed basis and is case specific to each application. The hybrid heating approach does not diminish the VFM process benefits.

The Hybrid Heating Solution

Hybrid heating consists of combining VFM and thermal heating. This combination is typically beneficial and minimizes the VFM powers required to execute the process recipes pertaining to assemblies with heat sinks and massive metallic handling media. The heating component of hybrid heating can be of different kinds. The two most practical ones are: 1- hot air inside the VFM cavity chamber and 2- a microwave suscepting fixture around the handling media. The utilization of hot air inside the VFM chamber (cavity) minimizes the temperature difference between the assembly and its environment. This reduction leads to faster ramp rates and overall shorter cycle times. The utilization of special fixtures is an effective alternative to heating the entire cavity with hot air. The special fixtures are designed to convert some of the microwave energy into heat which in turn limits the difference between the temperature of the assemblies and their local environment. The fixtures are captive to the VFM processing chamber and are not handled during production. In both cases, they reduce or eliminate the effect of heat sinking into a pallet and/or a substrate, created by the selective heating.

Lambda Technologies has been successful in implementing hybrid heating for production applications. In some cases, the hot air alternative makes more sense. For instance, applications where gaseous effluents are produced during processing are best served with the hot air alternative. In these cases the hot air provides the required thermal environment as well as the carrier for the gaseous effluents. In other cases, fixturing makes more sense. In these cases, a dedicated fixture is built to focus the microwave to heat conversion right where it is most needed. Once these fixtures are designed and made captive to the VFM chamber, they provide a simple alternative for hybrid heating.