5.1 INTRODUCTION

Subsystems based upon ICs wire bonded directly to printed wiring boards, have been important constituents of electronic products since the early 1970s. The density of these early systems was quite low and frequently did not connect many unpackaged die. Systems built with this process were said to be based upon chip-on-board (COB) technology. The term multichip module (MCM) has been widely used since the mid-1970s, but was not applied to modules based upon PWBs until the end of the 1980s. In the most common phraseology, the term MCM-L has come to imply an IC assembly comprised of multiple wire bonded die on a PWB. Other types of connection technologies, TAB and flip chip also are practiced in MCM-L systems, but COB assemblies have been the most common. COB involves the use of wire bonding and epoxy glob-top encapsulation, which are usually the lowest cost connection and sealing methods. These systems have typically been tested and burned in at the module level, and defective units are disposable. Higher cost, higher performance die often must be tested and burned-in prior to assembly, and the system cost forces planning for MCM repair. These higher performance die often have higher I/O counts, driving a higher module interconnect density than with the lower cost, disposable modules. Thus, COB modules have developed into a subset of MCM-L, where
the modules are disposable and built with untested die. The range of MCM-L technologies has widened considerably in the areas of the materials and methods of substrate fabrication, and in the types of die connection to the board. In all instances, the minimum set of MCM-L attributes is the connection of unpackaged die on a substrate, whose manufacture is based upon laminate process technology [1].

5.1.1 MCM-L Amid the Spectrum of MCM Substrate Technologies

While the definitions of MCM substrates are discussed in Chapter 1, a cursory review of MCM substrate technologies is useful in view of the broad range of technologies available with laminate structures.

PWBs are known as organic boards since the primary constituent of the board dielectric is an organic polymer. The dielectric layers are supported most often by a reinforcing fabric, usually based upon woven glass fibers. Usually, there is no substrate underlying, or supporting, the laminate structure, as there is with MCM-D substrates where the typical dielectric (organic or inorganic) is very thin and would be structurally inadequate if not formed upon more rigid substrates such as Si, ceramic, metal or an organic laminate (PWB/MCM-L).

All MCM substrate technologies offer a wide range of material and structural options. Conductor options also are available with MCM-D (Cu, Al), and with MCM-C (W, Mo, Cu, Ag, AgPd). MCM-L conductors primarily feature Cu, but in certain structures Al and polymer thick films are used. MCM-D has numerous organic dielectric possibilities, and while silicon dioxide is the prevalent inorganic dielectric, other possibilities such as silicon nitride and spin on glasses are possible. MCM-C similarly offers a wide range of ceramic dielectric materials. MCM-L allows the use of many polymer dielectrics and reinforcing structures and materials (woven fabric, random matt, porous thermoplastics, particulates such as glass, graphite, fused silica).

Laminate boards can attain a high degree of rigidity after lamination due to the presence of the high modulus of elasticity fibers in the reinforcement phase, while particulate fillers are not as effective in imparting stiffness to laminates since they are not a continuous phase in the xy-plane. When dielectric layers use no fiber reinforcement, the resulting laminate can be quite flexible, leading to the term flexible ("flex") circuits. Combining both types of laminates in a single laminate product leads to structures called “rigid-flex.” Thin film-type processing on MCM-L surfaces has been reported by several companies. Such processing includes fully additive and subtractive processing of conductors as well as the processing of dielectrics from liquid precursors or from supported or unsupported films. This creates a hybrid structure which takes advantage of the low cost of MCM-L and the enormous interconnect density provided by thin film