10.1 Introduction

The complexity of building an area-array manufacturing line is similar to constructing standard electronic-packaging facilities. Decisions which affect the productivity of a manufacturing plant span from initial package design to finished product inspection. As with any manufacturing operation, tradeoffs must be constantly evaluated to achieve an acceptable balance between quality, production, cost and reliability objectives.

Area-array, flip-chip interconnection processes have been practiced by a limited number of companies since the 1960's. Initially, due to the lack of a sufficient industry infrastructure, production tooling was custom designed and manufacturing standards and practices varied. As area-array processes were introduced to a broader spectrum of the electronics industry, standardized operations and commercial tooling have become more readily available. Today, there are multiple commercial-equipment suppliers for virtually all primary area-array component manufacturing operations, and industry standards and practices are being deployed.

This chapter discusses the key practices and options to consider when establishing and operating an electronic-package manufacturing facility capable of handling area-array components, including area-array dice and ceramic package interconnection operations. Various factors and their effects on a manufacturing line are discussed, among them are: package design, process flow, equipment, materials, handling, process monitoring, and yield.
10.2 Product Release

The initial procedure is to properly re­lease all the components, materials, etc. to the various manufacturing operations or sta­tions required to complete module assembly. A manufacturing plant may be designed to handle a single module design, with a single set of component and material part numbers, or it may be required to produce multiple assemblies with many different components, materials and processing requirements. In ei­ther scenario, the release of materials and components to the manufacturing line should be controlled and documented along with the processing instructions. The control and traceability of materials and components assists in the analysis of problems which may arise with completed assemblies and is often a quality requirement.

To maximize line efficiency, the released assembly batch size should be as large as pos­sible and matched to the overall tooling ca­pacity. It is generally recognized that the line efficiency is preserved by matching the smallest batch size to the capacity of the assembly step with the longest cycle time.

10.3 Flux Application

Flux application is a key parameter in the placement, joining and cleaning of compo­nents. Therefore the amount, chemistry, dis­tribution, and uniformity of the flux must be monitored. The complexity of the process parameters and the need to operate within the process window are key issues in de­ciding which flux application is selected. The choice also greatly influences the preferred choice for cleaning. To optimize the place­ment and cleaning processes, the flux type and amount dispensed must be compatible with the furnace reflow thermal profile, and cleaning must comply with module yield and reliability requirements.

10.3.1 Application Methods/Tools

Flux is applied to either the solder bump area-array on a die or mating pad array on a carrier. Flux serves two purposes and is critical to high yields: it acts as a temporary ad­hesive to hold a die in place until reflow has commenced, and promotes improved solder wetting of the chip-carrier pads during the join process. The most common fluxing tools are; manual, spray, and contact fluxing.

10.3.1.1 Manual application  Manual fluxing, the simplest method of fluxing, is compatible with manual and automated placement tools. A brush or sponge applicator is used to wipe flux on the carrier pad array. Manual adaptations of other contact and spray fluxing concepts are also worth considering in unusual circumstances. Flux must be uniformly applied to the entire pad array to avoid yield and reliability problems. The flux layer should be thin to prevent chips from floating in the flux, prevent problems with automated vision systems, and minimize subsequent cleaning requirements. For manual placement tools, flux is applied between the final alignment and placement steps.

10.3.1.2 Spray fluxing  Spray fluxing in­volves spraying a fine mist of flux, or a de­position of air-dispersed droplets, on either the die or carrier array surface. It requires unique tooling not normally incorporated into auto­mated placement tools. Spray-flux tools are normally placed just before placement tools in a manufacturing line so that flux can be applied prior to chip placement. An example of a site covered with flux applied by spray fluxing is shown in Fig. 10-1. Spray-flux tools have varying operating capabilities regarding flux viscosity range, pattern size, and pattern definition.

**Equipment.**

- Typical suppliers: Nordson, SonoTek
- Attributes: Spray control, spray width, high speed, viscosity limited.

10.3.1.3 Contact fluxing  Contact fluxing is achieved by dipping the die area-array solder bumps into a thin layer of flux (Fig. 10-2) using a rotating platen or other moving or