List of Contents and Author Index for Volume 28, 1997, are inserted loose in this issue

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CONTENTS

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0026-2692(1998)29:6;1-I

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Chip on glass—interconnect for row/column driver packaging

Rajeev Joshi*

National Semiconductor Corporation, 3707 Tahoe Way, Santa Clara, CA 95051, USA

New liquid crystal active matrix color flat panel displays and super twisted nematic liquid crystal displays and other flat panel displays are driving new interconnect technologies to make low cost, thin, compact, mass terminations with high resolution capabilities. Chip on glass (COG) and flip chip on glass (FCOG) are being used to mount the driver IC directly on to the glass LCD. FCOG and COG offer the highest density possible in packaging. Several interconnect technologies in FCOG/COG have been developed; their strengths and weaknesses are discussed in this paper. The challenges for COG adoption are also discussed. © 1998 Elsevier Science Ltd. All rights reserved.

1. Introduction

The liquid crystal display (LCD) market can be considered to be a large application of the flip chip market in the form of chip on glass (COG). It is estimated that about 60% of the displays use tape automated bonding (TAB) technology. In Japan, COG is typically used for LCDs that are under 6 inches in size. Figure 1 gives typical adoption rates for COG as a function of the panel size.

*Tel: (408) 721-4326. Fax: (408) 746-2007. E-mail: trajsc@ptg.nsc.com.

For display driver IC to glass interconnect, a key requirement of the process is that it should be low cost, manufacturable and reworkable.

Several methods have been used historically to interconnect driver ICs to the glass. For example, conventional packages like a thin quad flat package (TQFP) on a printed wiring board, which in turn is connected to the glass using flex. A fine pitch chip on tape package like the tape carrier package (TCP) is also currently used. The outputs of the driver IC on the TCP are connected to the glass using anisotropic conductive epoxy. In COG, the bare (unpackaged) driver ICs are mounted directly on the glass panel. Thus, COG has the potential of using the most simplified assembly process flow and as it does not involve the use of a conventional package (like TCP), it can be a low cost interconnection method.

One method to connect the mounted die is by wire bonding the IC to the metallization on the glass. In this method, the interconnects are made to the metallization one bond pad at a time. This method is also not very efficient in supporting high density or fine pitch interconnect, though it is an inexpensive and mature interconnect method in the industry.

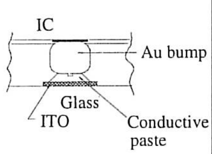
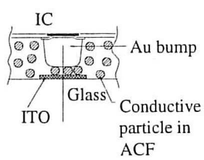
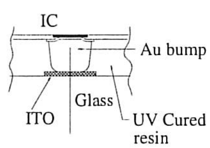
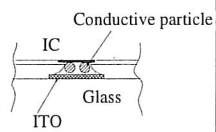
An alternative interconnect process is flip chip on glass (FCOG). FCOG is a system level interconnect and should be treated as such.

2. COG

Several methods exist for attaching bare driver ICs on to glass. A review of their technologies along with their key attributes is given in Table 1.

From Table 1 the method that uses modified conventional assembly equipment is stud bumping, which eliminates the need for lithography and associated mask costs. The most common method, however, for COG, is the use of adhesives for accomplishing the interconnect. Figure 2 gives the process flow for these two processes.

Two types of adhesive processes exist: one where the epoxy which facilitates electrical contact between the bump and the trace metallization without itself being in the conduction path, as in UV curable resins, or are in the

Method	Stud Ball Bumps	Anisotropic Conductive Film (ACF)	Micro Bump Bonding (UV Resin)	Conductive Particle
				
Interconnect	Conductive Paste	ACF	None	Conductive Particle
IC Electrode	Au Ball on Al Pad	Au Bump	Au Bump	Al Pad
Conductor on Substrate	ITO	ITO	ITO	ITO
Pitch (μm)	60-130	150-200 (recent work shown up to 40 micron)	50	60-130
Bond Temperature	100-120 C	160-180 C	room temp	150-200 C
Bond Pressure	1-2 g/pad	20-50 g/pad	10-20 g/pad	10-20 g/pad
Cure Method	Thermal	Thermal	UV	Thermal
Repairability	Poor after underfill	difficult	very difficult	difficult
Benefits	- Flexible bumping method - low capital		-Low cost High thru'put	-No bumps needed
Drawbacks	-one at a time bumping			-Unreliable connection with Al

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