ESD Association Technical Report

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For Challenges in controlling ESD in the manufacturing of Flat Panel Displays

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FOREWORD

Flat panel displays (FPD) are used for computer monitors, cell phones, tablet PCs, televisions, and many other devices. As the FPD was developed and transferred to mass production manufacturing, there were no universally accepted factory ESD control guidelines or documentation. There are no ESD testing models that are applied specifically to FPD throughout the industry. As the first step, WG21 has decided to collect the recent studies and publications of the members of the WG into a technical report (TR). The goal of this TR is to provide examples of ESD field failures in FPD industry and to provide factory ESD control guidelines. A second document will address testing methodology. This document may apply to other flat panel substrate devices such as flat panel x-ray detectors.

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At the time ESD TR21.0-01-18 was prepared, the 21.0 Flat Panel Display subcommittee had the following members:

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1.0 INTRODUCTION

ESD in the flat panel display (FPD) industry is an increasingly important issue, primarily due to FPD technology changes and the continuously increasing size of the bare glass substrates. Since the FPD industry began, there has been a need to control static charge levels in the factory. Each FPD manufacturer had a different ESD control strategy and deployed different ESD countermeasures. Unfortunately, there was no unified attempt to understand the true sensitivities of the FPD and the effectiveness of any ESD control techniques. This technical report will describe some of the more critical static charge related issues in FPD manufacturing. To describe static related issues for FPDs, the working group decided to compile recent publications of the members of the WG in one technical report (TR). The goal of the TR is to give the reader examples of static charge related issues within an FPD manufacturing environment. A future document will develop test methods for FPD devices.

2.0 ESD ISSUES IN THE FPD MANUFACTURING ENVIRONMENT

2.1 Direct Contact Process Fixture and Stage Material Analysis

NOTE: This section is a reproduction of several paragraphs in [1] and [4].

2.1.1 Introduction

Thin film transistor liquid crystal displays (TFT) are widely used in FPD televisions, notebook PCs, various flat monitors, and portable electronic equipment such as mobile phones and tablet PCs. Since the TFT device is composed of a number of layers and most of the processes to integrate the layers involve movement, friction, and separation of glass substrate from various materials, electrostatic charges are inevitably created during the manufacturing process. The FPD are basically a glass substrate with a transparent metal coating for the electrodes of the display. This insulating glass material can generate a high level of electrostatic charge and maintain the charge for a relatively long time. ESD damage could result from this charge generation. ESD problems become even more critical as the glass substrate becomes thinner, which is the current trend.

TFT manufacturing processes are very similar to silicon wafer semiconductor processes. The major difference for TFT manufacturing is that the substrate is not a silicon semiconductor, but a highly insulative glass plate. There is a different ESD failure mechanism on glass panels and this results in ESD becoming a major yield issue in TFT manufacturing processes compared to semiconductor processes which use conductive wafers. ESD defects are still only a minor issue with semiconductor wafers.

During TFT fabrication processes, a variety of charge generation methods cause static charge problems. Static charge is generated by the friction from photoresist coatings applied to the glass surface and deionized water spray rinses used to clean the surface. Triboelectric charge generation occurs when transferring glass plates between processes on conveyor rollers. Another method of triboelectric charge generation is the pressure and separation of glass panels on a vacuum chuck or process stage. Most of FPD processes are done on process stages which look like a large worktable. Lift pins are used to lower the glass substrate on to process stage, and then to lift glass substrates before transfer to the next process. Generally, more than 40 contact and separation steps are needed to complete a panel. Whenever two surfaces in close contact are separated, one surface loses electrons and becomes positively charged, while the other surface gains electrons and becomes negatively charged. After separation, each surface retains its positive or negative charge, unless the surface is conductive and a path to ground is provided. With glass substrates grounding cannot be a solution. Air ionization is recognized as the most effective means of neutralizing static charge on the glass panel but it is not enough to completely control the static charge.