

## 13.1: Effect of Scribing Wheel Dimensions on the Cutting of LCD Glass Substrate

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### Abstract

The influence of the scribe wheel angle and diameter to the scribing and the breaking of LCD glass substrate, Code1737F, were experimentally investigated. A wheel having 130° tip angle and 4mm in diameter have shown the best results, allowing sheet separation at the lowest breaking force.

### 1. Introduction

Scribe and break method for glass cutting is widely used to separate each Liquid Crystal Displays (LCD) panel from a large mother substrate cell. Scribing is key to the glass cutting process, a median crack created by the scribing without lateral cracks is needed for clear cutting of the mother cell. We have studied median crack creation and proposed the mechanism that the median crack can be considered as continuous half-penny cracks created by point indentation [1]. Although scribing conditions such as scribe wheel dimensions, scribing load, scribing speed etc, have been well optimized empirically in manufacturing experience, faulty cutting in which the break deviates from the scribed line is still a significant process loss. There has been no systematic study to find the scribing condition without the break deviation. This experimental study is designed to find a relation among the scribing wheel angle, wheel diameter, and crack creation and propagation as a function of scribing load for a simple case of a fusion-drawn glass substrate.

### 2. Experiments

As-formed Code 1737F glass sheet by fusion method having 1.1mm in thickness is used for the sample sheet. The mechanical properties of the Code 1737F glass are listed in Table 1.

Table 1 Mechanical properties of glasses

Glass	Code 1737 F
Composition type	Alkali-earth Aluminoborosilicate
Density, $\rho$ [ $\text{g}/\text{cm}^3$ ]	2.54
Young's modulus, E [GPa]	72.1
Poisson's ratio, $\nu$	0.22
Hardness, $H_V$ [GPa]	5.5
Fracture toughness, $K_{IC}$ [ $\text{MPa}/\text{m}^{1/2}$ ]	0.83

A sample sheet having 40mm x 50mm size was scribed at the center of the 50mm edge at several scribe loads. The details of the sample preparation were described in Ref. 2.

The tested wheel dimensions are listed in Table 2. The sample sheet was broken with four-point bending test (FPBT) along with

scribe line to measure the breaking force of the scribed sample. The median crack depth of the broken specimen was measured with a Laser Scanning Microscope (SLM).

Table 2 Wheel angle and diameter

By Mitsubishi Diamond Ind. Co, A140 grade

	Tip angle [degree]	Diameter [mm]
Wheel 1	110	4.0
Wheel 2	120	4.0
Wheel 3	130	4.0
Wheel 4	120	2.5
Wheel 5	120	3.0

The median crack was created by indentation and rolling of the scribe wheel at a speed of 300mm/sec. and scribing loads of 5N to 25N.

### 3 Results and Discussions

#### 3.1 Median crack depth created by various wheel

Figure 1 shows median crack depth using various wheels listed in Table 2 as a function of scribe load. The median crack depth increases with increasing scribe load. It also supports common practical knowledge that wheels having smaller diameter and steeper tip angle create deeper median cracks. However, the

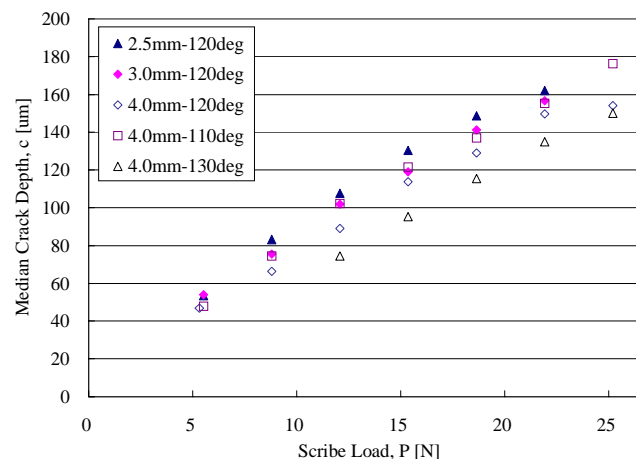


Figure 1 Median crack depth versus scribe load created by scribe wheels having various dimensions as shown in Table 2.