

Development and Exploitation of Processes For Thin Flexible Glass

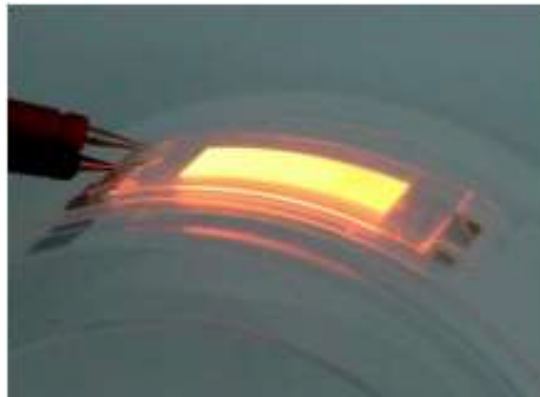
Wednesday 14th May 2014

Touch panel manufacturing on thin flexible glass

Helios@14/05/2014

Outline

- Thin glass
- Touch panel R2R manufacturing processes and challenges
- Summary



Thin glass manufacturers

AGC



Nippon electric glass

CORNING

SCHOTT
glass made of ideas

Current transparent substrates manufacturing process

Glass for Sheet to sheet

VS

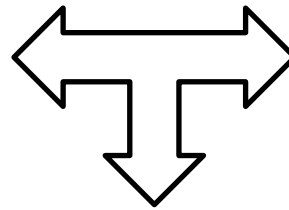
Film for Roll to roll



Performance:

- High temp processing
- Optical performance
- Sheet resistance
- Surface quality

High performance
but relatively high cost



High performance
and low cost?
R2R thin glass
manufacturing?

Performance:

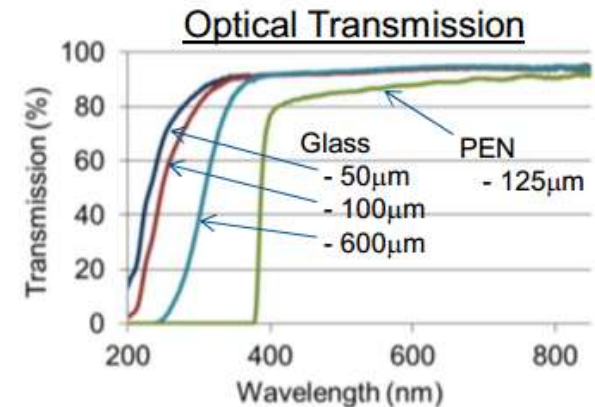
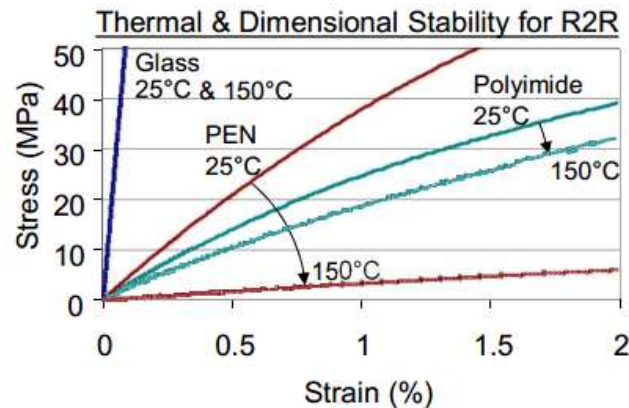
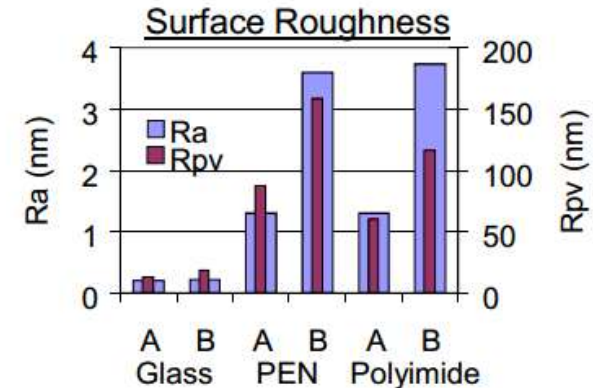
- Enable applications require flexibility of substrate
- Most important benefit is fast and low cost

Low performance
but low cost

Advantages of thin glass over other alternatives

Summary

- Excellent barrier properties
- High thermal stability
- High resistance to UV light
- Long-term stability
- High transmission
- High chemical stability
- Low surface roughness
- Cost savings by enabling R2R processes
- Thinner and lighter



PEN - Polyethylene Naphthalate

[Taken from Corning Inc]

Thin glass specifications

Company	Schott		Corning
	AF 32 eco	D263 T eco	Willow
Available thickness	25um-100	25um-100um	50um-100um
Sizes	<=500mm wide, Flexible length	<=500mm wide, Flexible length	<ul style="list-style-type: none"> • <=500mm wide, <=300m long (ITO) • <1m wide, <=300m long (No ITO)
transmittance τ	91.9%	91.7%	~92%
Coefficient of mean linear thermal expansion	$3.2 \cdot 10^{-6} \text{ K}^{-1}$	$7.2 \cdot 10^{-6} \text{ K}^{-1}$	$3-5 \cdot 10^{-6} \text{ K}^{-1}$
Transformation temperature T_g	717 °C	557 °C	NA
Dielectric constant ϵ_r at 1MHz	5.1	6.7	5-6
Refractive index n_d	1.5099	1.5230	NA
Density ρ (annealed at 40 °C/h)	2.43 g/cm ³	2.51 g/cm ³	2.3-2.5
Advantages	<ul style="list-style-type: none"> •CTE similar to silicon •High transmittance •Fire-polished surface with low roughness •Environmentally friendly production 	<ul style="list-style-type: none"> •High chemical resistance •Stable against sunlight and heat •High luminous transmittance •Environmentally friendly production 	NA

Potential applications

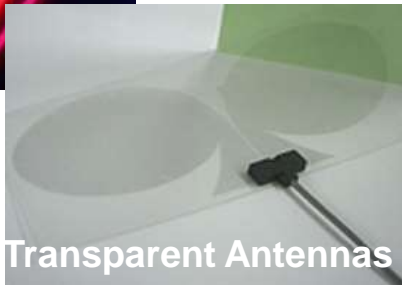
Passive Matrix display



Smart windows



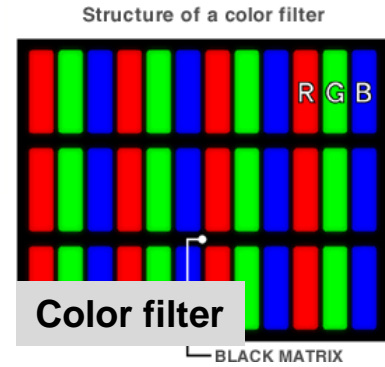
Lightguides



Transparent Antennas



Touch panel



OLED lighting



Protective Surfaces



Solar panel

R2R manufacturing for touch panel application

Requirements:

1. Materials supply
2. Machine that can handle thin glass in R2R form
3. Corresponding processes for the application(s)

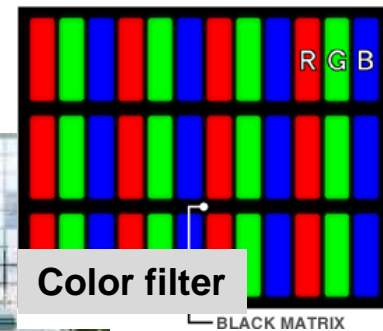


R2R Processes for making touch panel:

1. Plasma cleaning
2. Transparent conductor deposition
3. Inkjet printing metallisation
4. Laser curing/IR curing
5. Laser patterning of transparent conductor
6. Laser cutting (part singulation).....



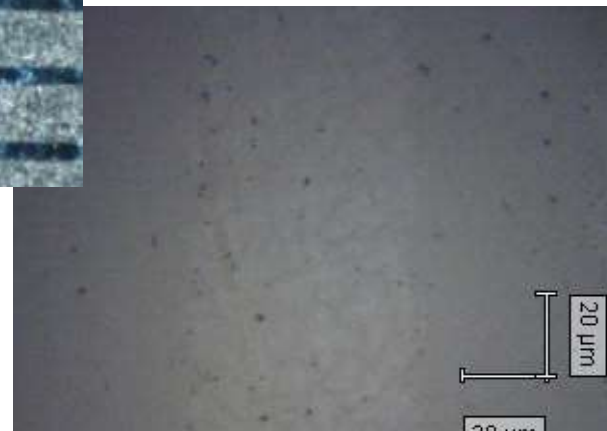
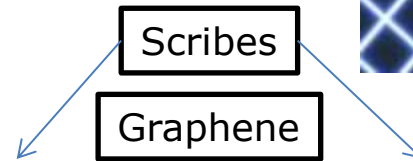
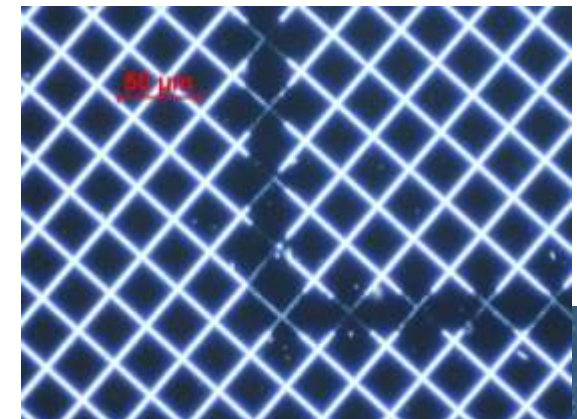
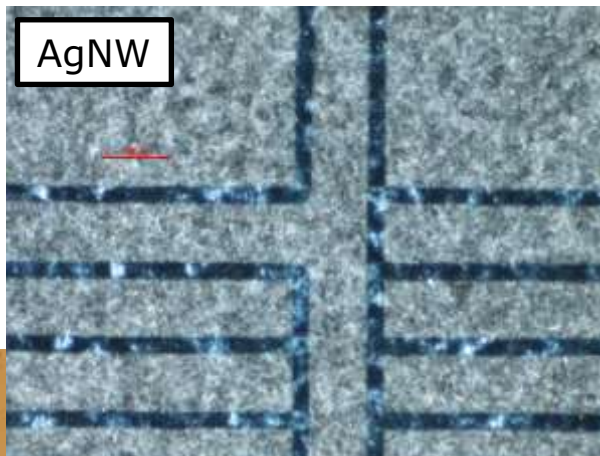
Structure of a color filter



R2R Process requirements for touch panel application

Laser patterning of TC (ITO, AgNW, graphene, metal mesh,....)

- Track width
- **Scribe visibility**
- **Damage to substrate**
- Selective ablation



ITO (in cell)

R2R Process requirements for touch panel application

Laser patterning of TC - Scribe visibility

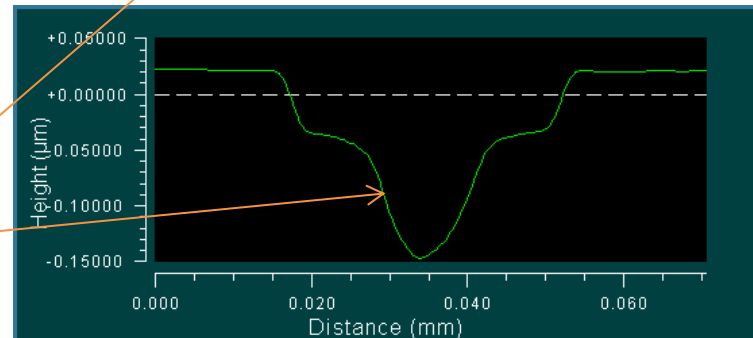
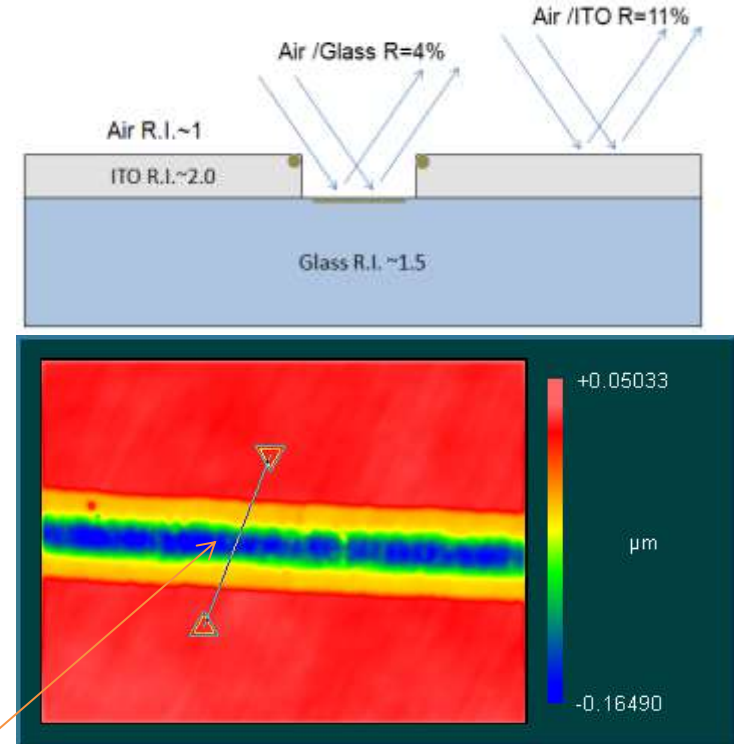
1. Edge (shoulders of the scribe)
2. Trench (damage to the substrate & residual of TC)
3. Width of ablated scribe
4. Refractive index between TC and substrate



Edge

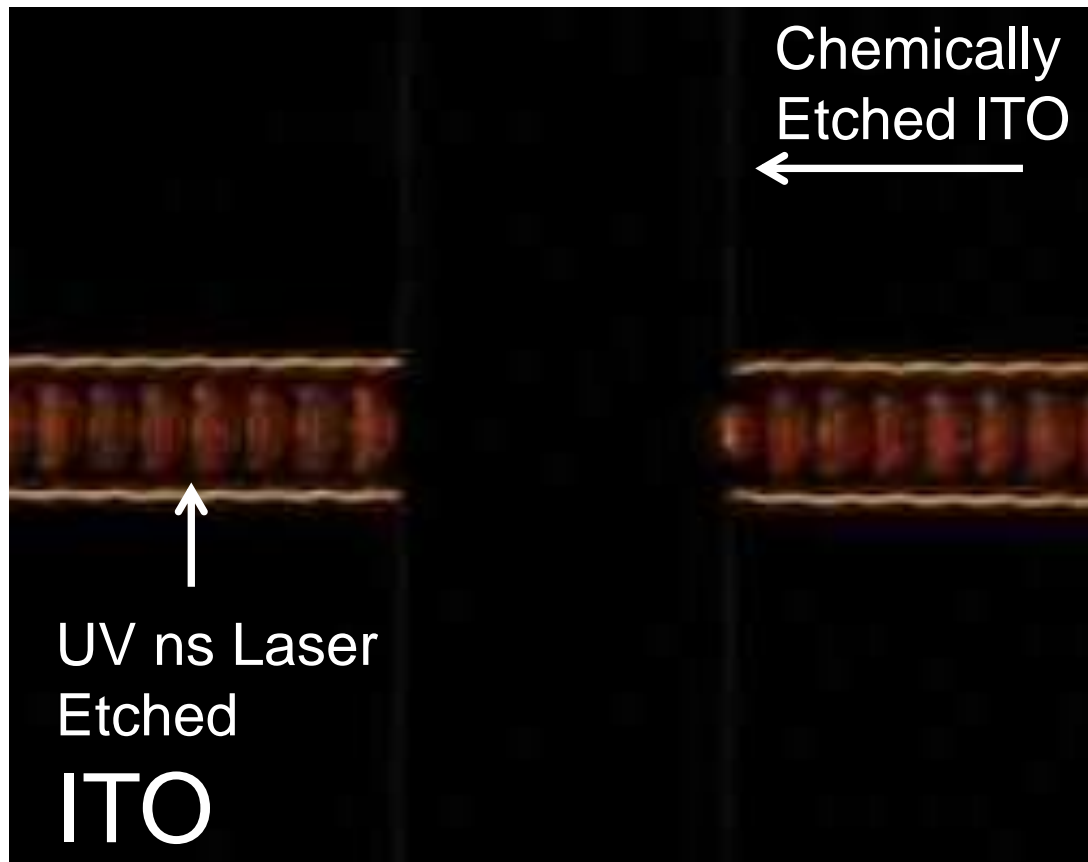
Center

The surface profile depicts that the beam penetrate over the depth of ITO, showing a glass damage.



R2R Process requirements for touch panel application

Laser patterning of TC - Scribe visibility

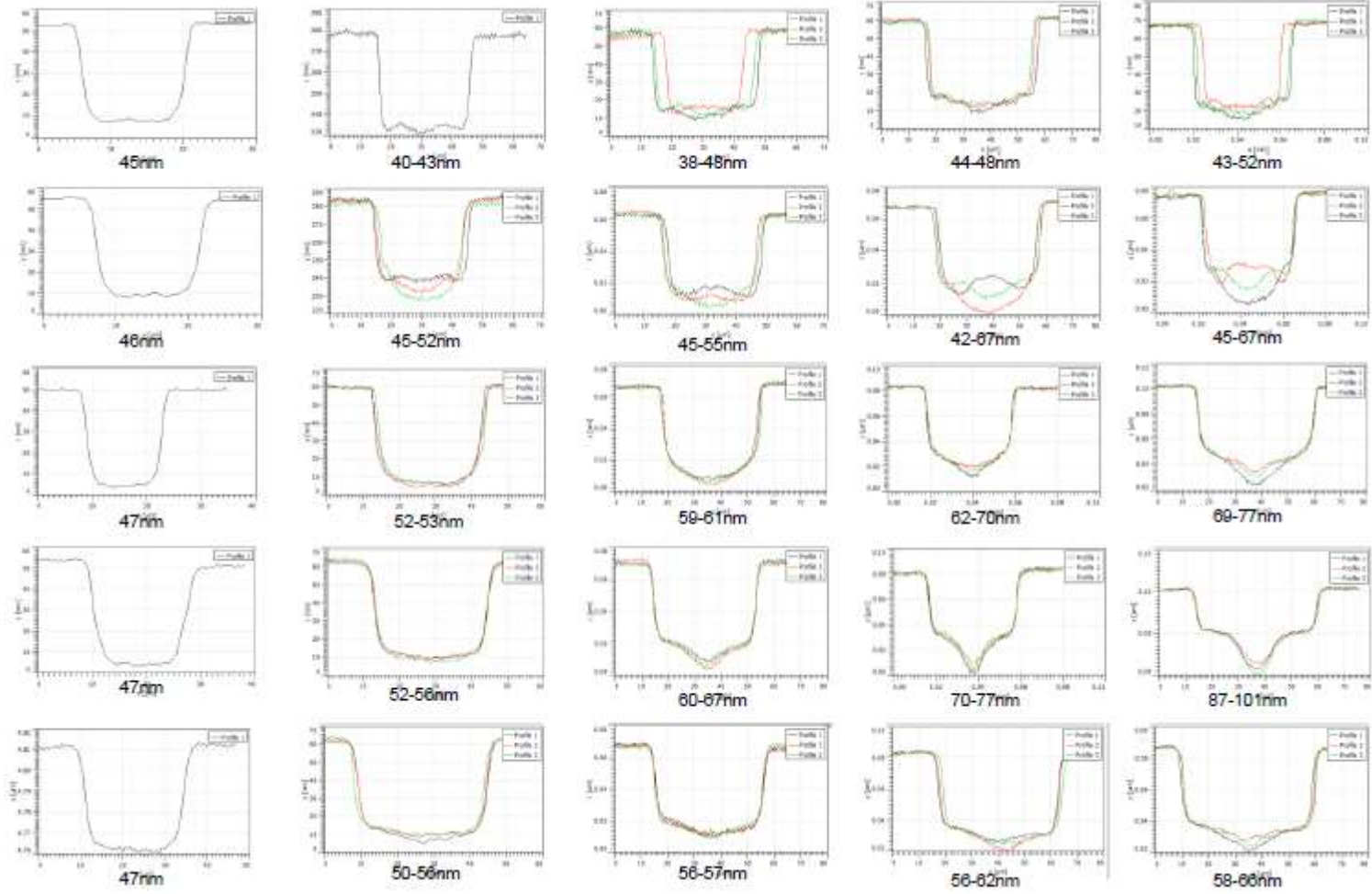


R2R Process requirements for touch panel application

Laser patterning of TC - Scribe visibility & glass damage

SPA

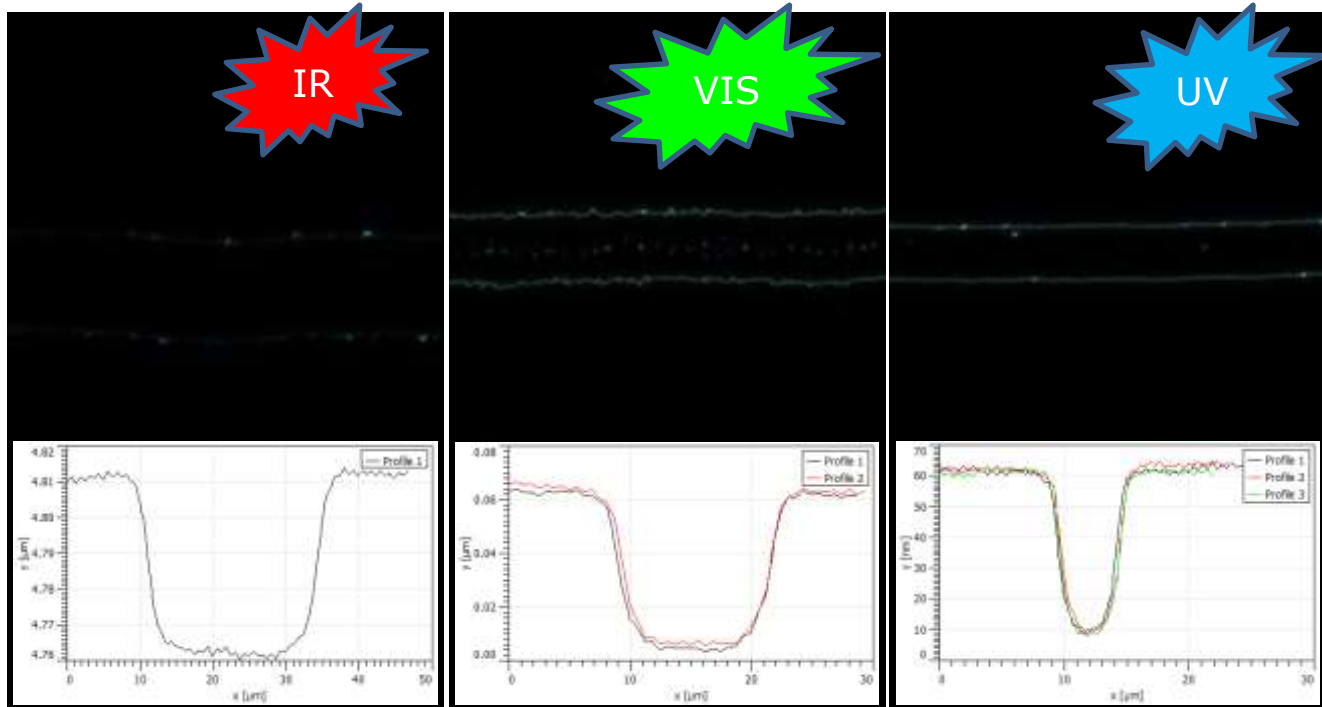
Pulse Energy →



R2R Process requirements for touch panel application

Laser patterning of TC - Scribe visibility shoulder

Dark Field
optical
images



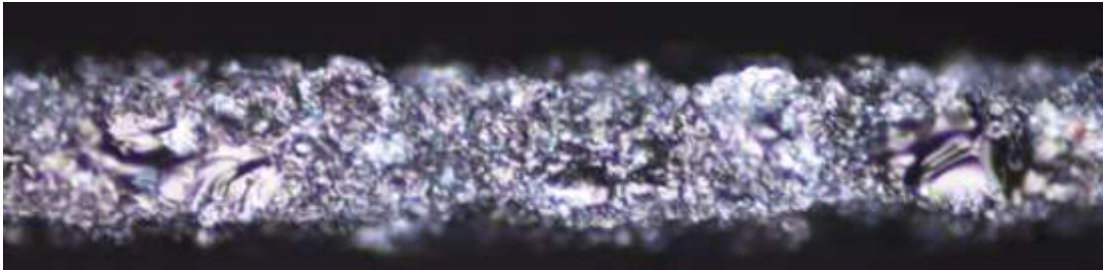
White light
interferometer –
depth profile

Pulse width, pulse energy, SPA??

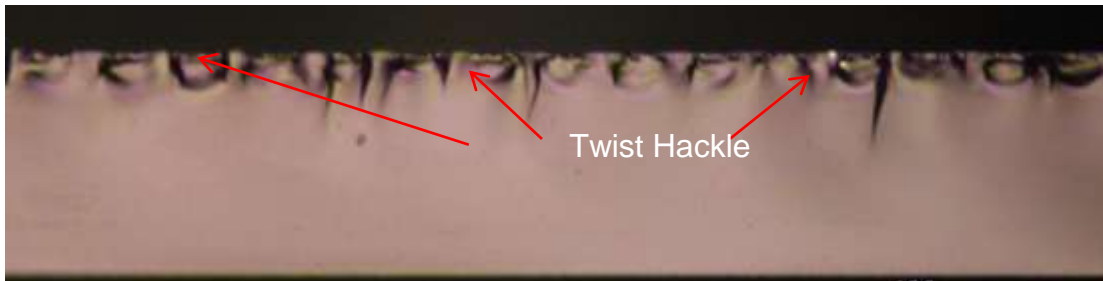
R2R Process requirements for touch panel application

Laser cutting (parts singulation)

Optical Examination of Cut Edges



UV Laser Ablation Cut Edge



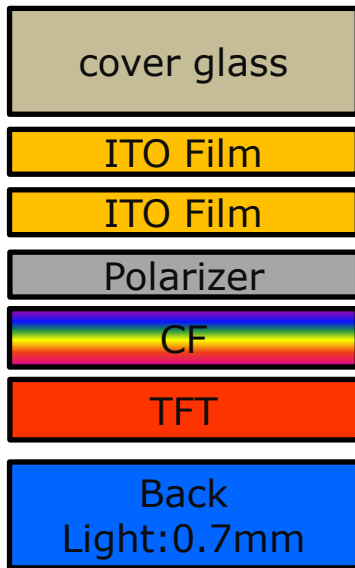
Mechanically Cut Edge

- Presence of twist-hackle
- Periodic median crack similar to notched or Penett® wheel

Touch-screen-based smart phone

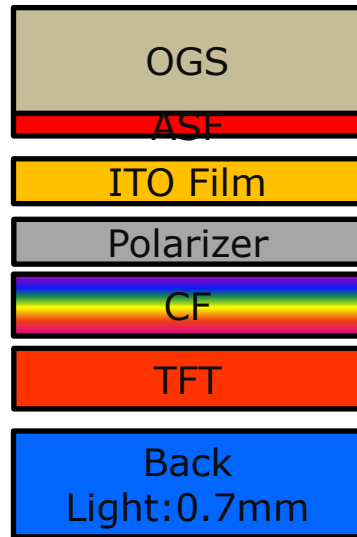
Current stack up

GFF



1.9mm + BLU

OGS



1.7mm + BLU

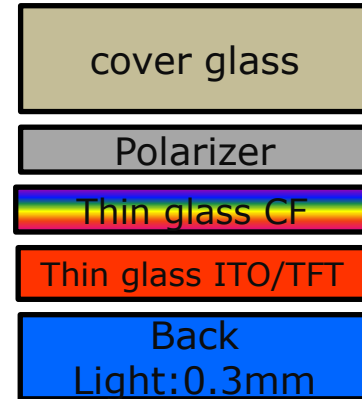
~2015??

On Cell



1.15mm + BLU

In cell



0.75mm + BLU



Touch panel manufacturing on thin flexible glass

Summary

- Thin glass
 - Background
 - Motivation
 - Advantages
- Touch panel R2R manufacturing processes and challenges
 - Requirements of R2R manufacturing processes
 - Materials supply
 - Machine that can handle thin glass in R2R form
 - Corresponding processes for the application(s)
 - Laser patterning of TC
 - Scribe visibility
 - Glass damage
 - Laser cutting (parts singulation)
- Impact of thin glass
 - Touch-screen-based smart phone

