The Nature of Catastrophic Shorts in OLED Lighting

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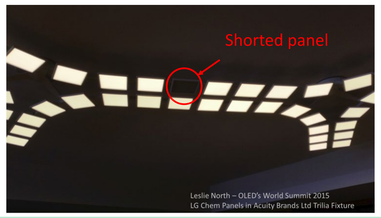
Catastrophic OLED panel failure

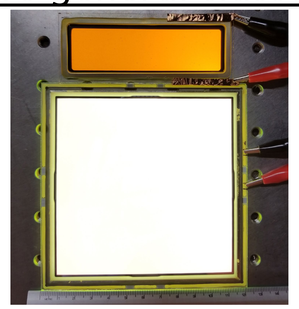
Prior to this work, catastrophic shorting was a major reliability challenge for OLED manufacturers.

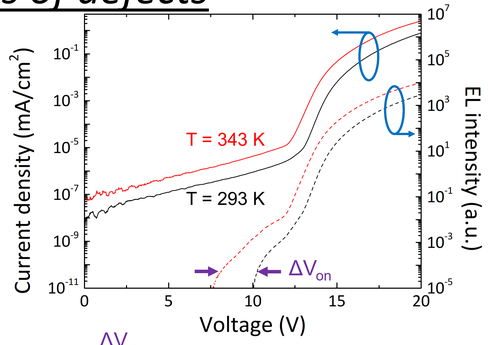
- Origin unknown
- Unpredictable
- Lack of mitigation strategy

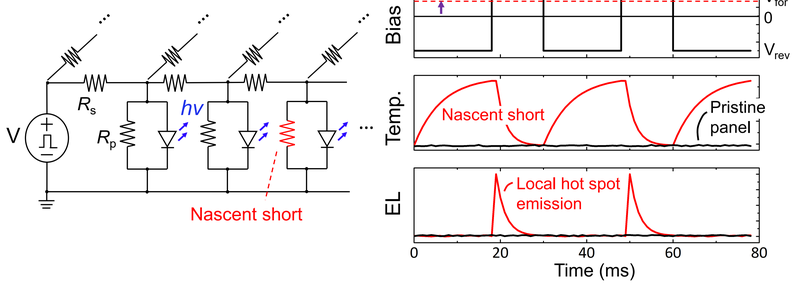


>> >> Understanding the nature of shorts is critical

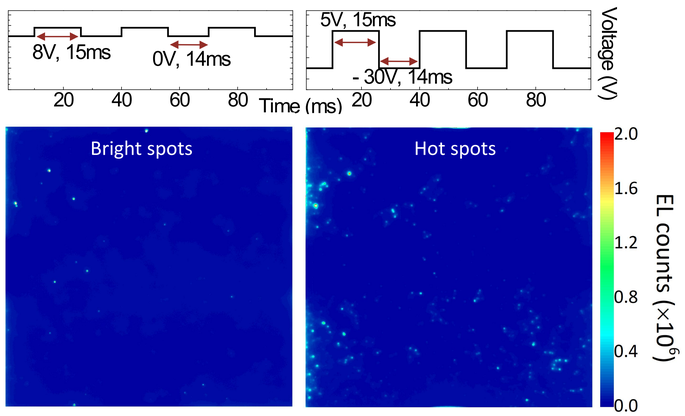
Two general classes of defects







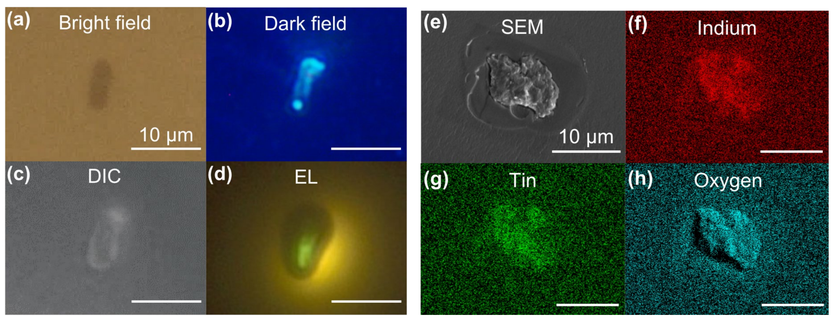
- Temperature-selective EL image



Previous work identified two classes of defects in commercial OLED lighting panels based on the electroluminescence drive condition.

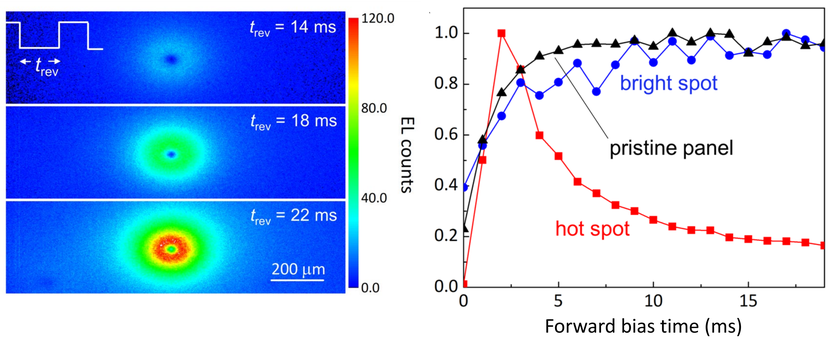
1. Bright spots: Local EL at subthreshold panel voltages.
2. Hot spots: Observed under temperature-selective EL imaging.
>> Hot spots & bright spots do not generally coincide

Bright spot: micron-scale ITO particles

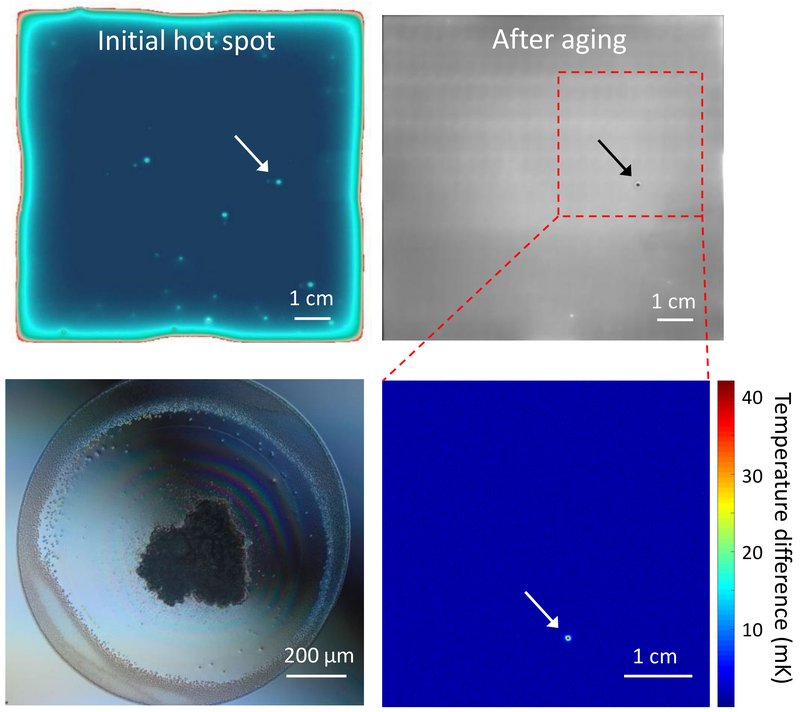


Shorts originate from hot spots

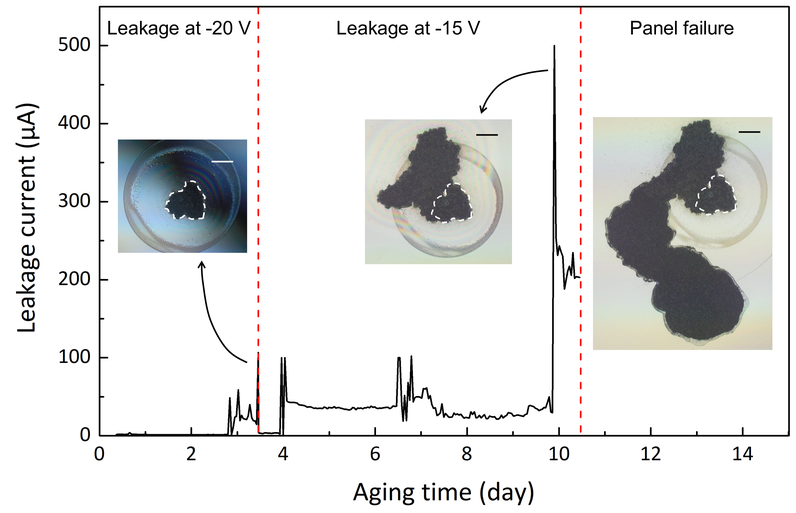
- Hot spot evolving with reverse bias duration



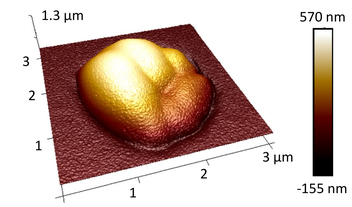
- Dark spot forming after accelerated fade testing on hot spot



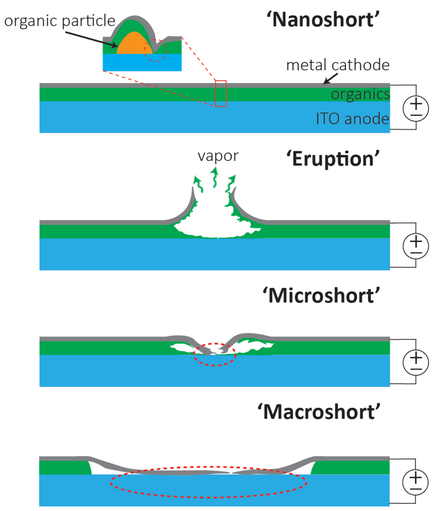
- Growth of the hot spot into the catastrophic short



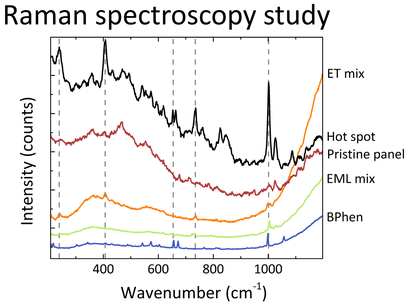
Trench around the hot spot



Key stages in the lifecycle of short



Raman spectroscopy study



Possible strategies
- Avoid shadowing
- Ultrathin dielectric layer
- Fuse-like layer

Conclusions

- Two different classes of defects identified: 'Bright' spots and 'Hot' spots.
- Bright spots are associated with ITO particles and are not precursors of catastrophic shorts.
- Hot spots are associated with particulates in the organic layer stack are precursors of catastrophic shorts.
- A model has been proposed for the growth of hot spots into catastrophic shorts.
- Proprietary new device architecture has been demonstrated to arrest growing shorts and eliminate catastrophic failure in production