

**isola**

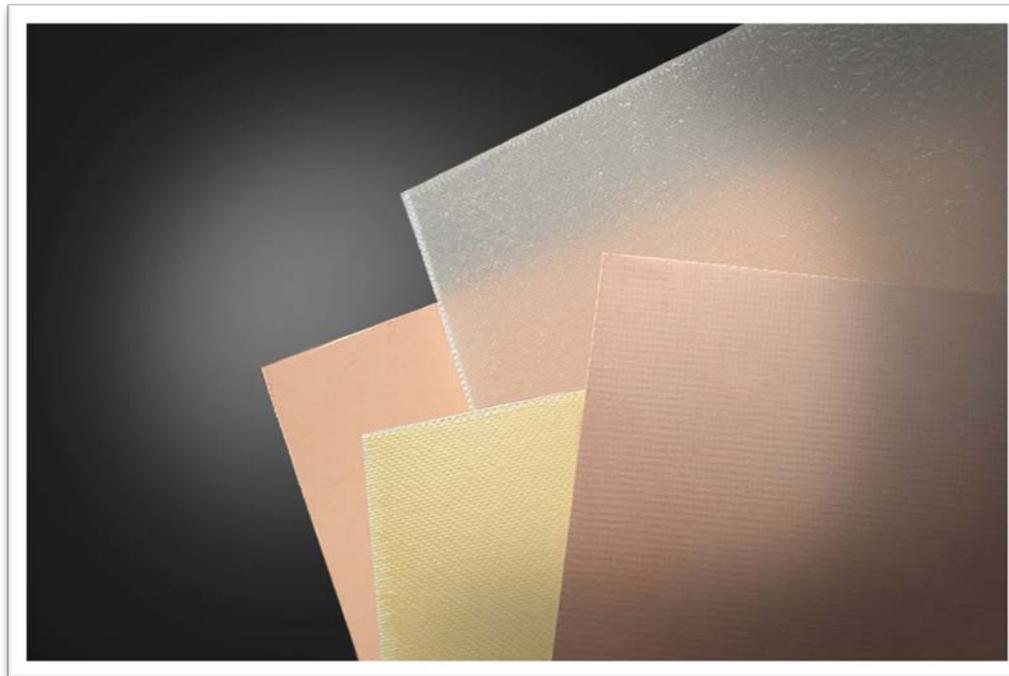


**Challenges and Opportunities for  
Halogen-free Flame Retardants in  
Anisotropic Composite  
Dielectric Materials for  
RF and Microwave Applications**

May 2015

# Introductions

- **David Bedner, Principal Scientist, Isola Group**
- **Isola supplies both halogen and non-halogen materials for PWBs**



# Overview

- **History of Flame Retardants (FRs) in Electronic Materials**
- **Challenges for Standard Brominated FRs and non-Halogen FRs**
- **Opportunities for Growth**

# Isola HF Product Portfolio

		<b>Tachyon®- 100G</b> Dk 3.00, Df 0.0021			
		<b>Chronon™</b> Dk 3.68, Low Skew			
		<b>I-Tera® MT</b> Dk 3.45, Df 0.0031	<b>Astra® MT</b> Dk 3.00, Df 0.0017		
		<b>GigaSync®</b> Low Skew	<b>I-Tera® MT RF</b> Dk 3.38, 3.45 & 3.56		
		<b>I-Speed® IS</b> Low Dk Glass	<b>IS680-345</b> Dk 3.45, Df 0.0036		
		<b>I-Speed®</b> Tg 180, Df 0.0065	<b>IS680-338</b> Dk 3.38, Df 0.0035		<b>Ultra-EC®</b> 25µ Laminate, Tg 170
	<b>185HR</b> Tg 180, Df 0.019	<b>FR408HR IS</b> Low Dk Glass	<b>IS680-333</b> Dk 3.33, Df 0.0034		<b>P96/P26</b> V-0/V-1 Polyimide
<b>TerraGreen®</b> Dk 3.45, Df 0.003	<b>370HR</b> Tg 180	<b>FR408HR</b> Tg 190, Df 0.009	<b>IS680-320</b> Dk 3.20, Df 0.0032	<b>P25N</b> Polyimide No Flow	<b>P95/P25</b> HB Polyimide
<b>Green Speed®</b> Tg 180	<b>IS410</b> Tg 180	<b>FR408</b> Tg 180, Df 0.012	<b>IS680-300</b> Dk 3.00, Df 0.0030	<b>FR406N</b>	<b>GETEK®</b> PPO/Epoxy
<b>DE156</b> Tg 155	<b>IS400</b> Tg 150	<b>IS415</b> Tg 200, Mid Dk/Df	<b>IS680-280</b> Dk 2.80, Df 0.0028	<b>A11</b>	<b>G200</b> BT/Epoxy
<b>Halogen Free</b>	<b>High Reliability FR-4</b>	<b>High Reliability, High-Speed Digital</b>	<b>RF/Microwave</b>	<b>No/Low Flow Prepregs</b>	<b>Speciality Products</b>
<i>Mid Tg/High Tg/ Low Dk Df</i>	<i>Mid Tg/High Tg</i>	<i>High Tg, Low Dk/Df</i>	<i>Low Dk, Low Df</i>	<i>Mid Tg/High Tg</i>	<i>High Tg</i>

All Isola products are RoHS compliant



# History of FR in Electronics

- **Underwriters Laboratory**
  - Established 1894
- **UL94 V0 is the industry standard**
- **Today many compliant companies in all regions**



**Underwriters  
Laboratories**

# Utilization of FR

## TV without Flame Retardant

Time (min/sec)  
0:08



Time (min/sec)  
7:23



Time (min/sec)  
8.00-9:00

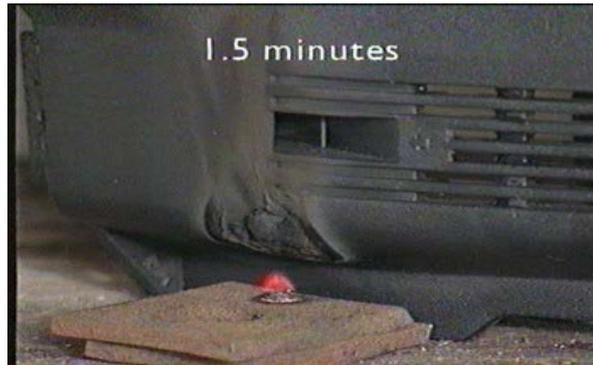


## TV with Flame Retardant

Time (min/sec)  
0:05



Time (min/sec)  
1:30



Time (min/sec)  
1.45



# Comparison of Flame Retardants

## Brominated FRs

- **>95% of FR-4 PWB use TBBPA**
- **Inexpensive**
- **Well studied**
- **Easily extracted**
- **Very efficient**
- **TBBPA NOT RoHS restricted**
- **REACH registered as of October 2010**

## Phosphorous FRs

- **Finite supply**
- **Has to be strip mined**
- **Not as efficient**
- **Many phosphorous compounds are explosive & neurotoxic**

# Not All Electronics Require FRs

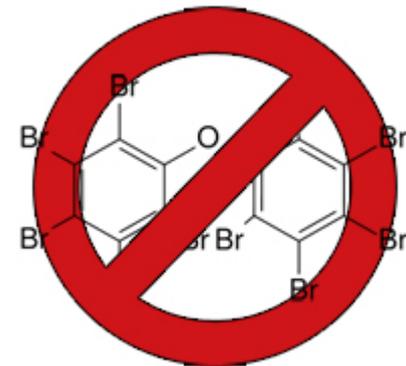


# Brominated FR Under Scrutiny

- **1996 Fire at Dusseldorf Airport**
  - 10x Dioxins Detected after Fire
- **DecaBDEs and PBDEs not in use**
  - TBBPA under attack

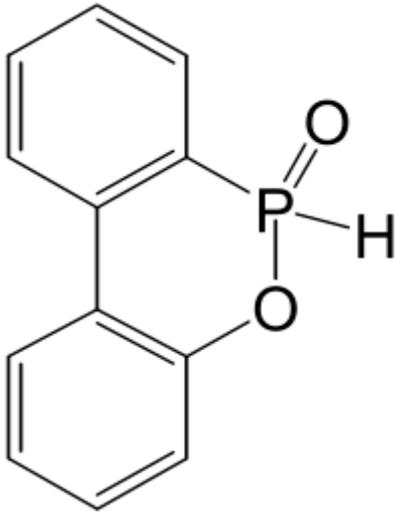


~~PDBE~~



# DOPO Arrive in the 1990s

*And It Worked!*



Reacted into Backbone  
Can Etch and Plate  
Thermally “OK”  
Cost “OK”

# Non-DOPO Developments 1995-Today

## ■ Additive

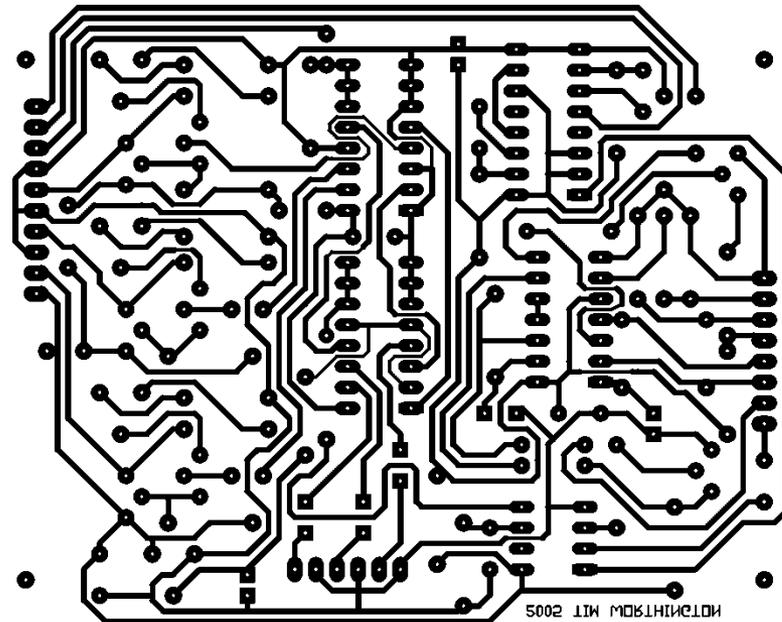
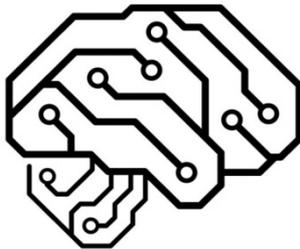
- >15 tested, 1 used today
- 3 new materials, 0 work

## ■ Reactive

- 3 DOPO-based used today
- Many knock-offs
- 4 new materials, 0 work

# 2015 DOPO Products

- **Still exist in commodity products**
- **Many drawbacks as technology advances**
  - Electrical
  - Mechanical
  - Thermal



# **Challenges How to make a PWB Critical Properties**

# Meets UL-94 Flammability Test



- Needs to extinguish a flame
- Needs to resist ignition
- Most PWBs require a V-0 rating
  - Total Burn <50s
  - Longest Burn <10s

# ISOLA Processing

- **Attributes**
  - Health and Safety
  - Compatibility
  - Shelf Life
  - Cost



# PWB Fabrication

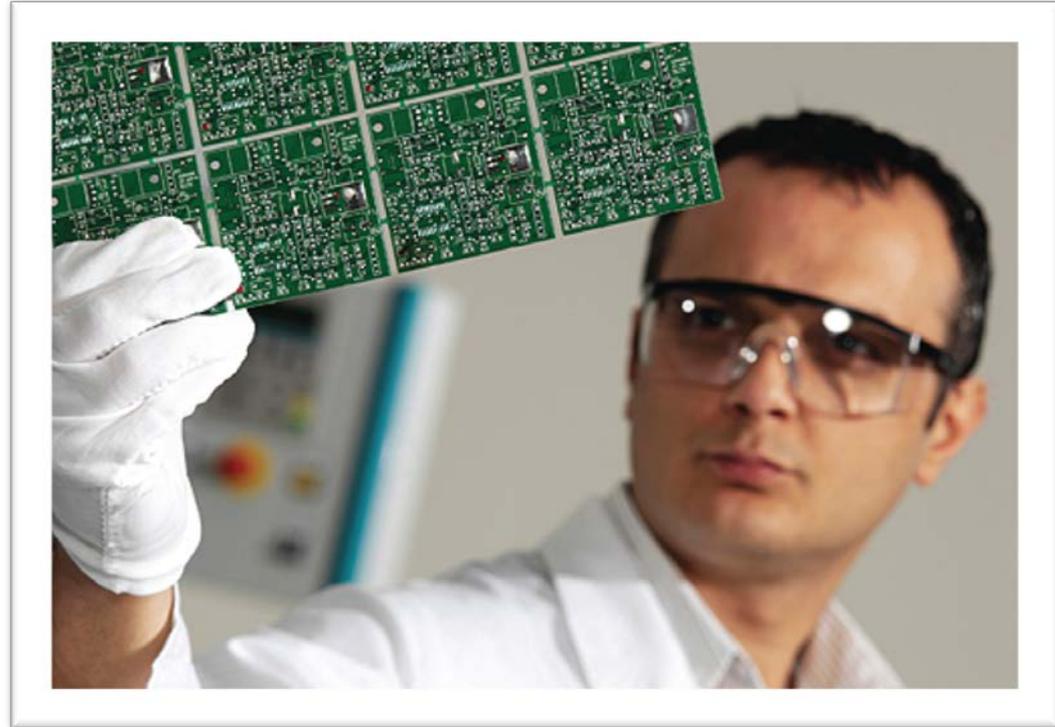
- **Print**
- **Develop**
- **Etch**
- **Layup / press**
- **Drill**
- **Desmear**
- **Electroless Copper Cu Plate/Sn Plate**
- **Print**
- **Develop**
- **Etch/Sn-Strip**
- **Apply Solder mask**
- **Solder (Many Varieties)**
- **Test**



# PWB Fabrication & OEM Requirements

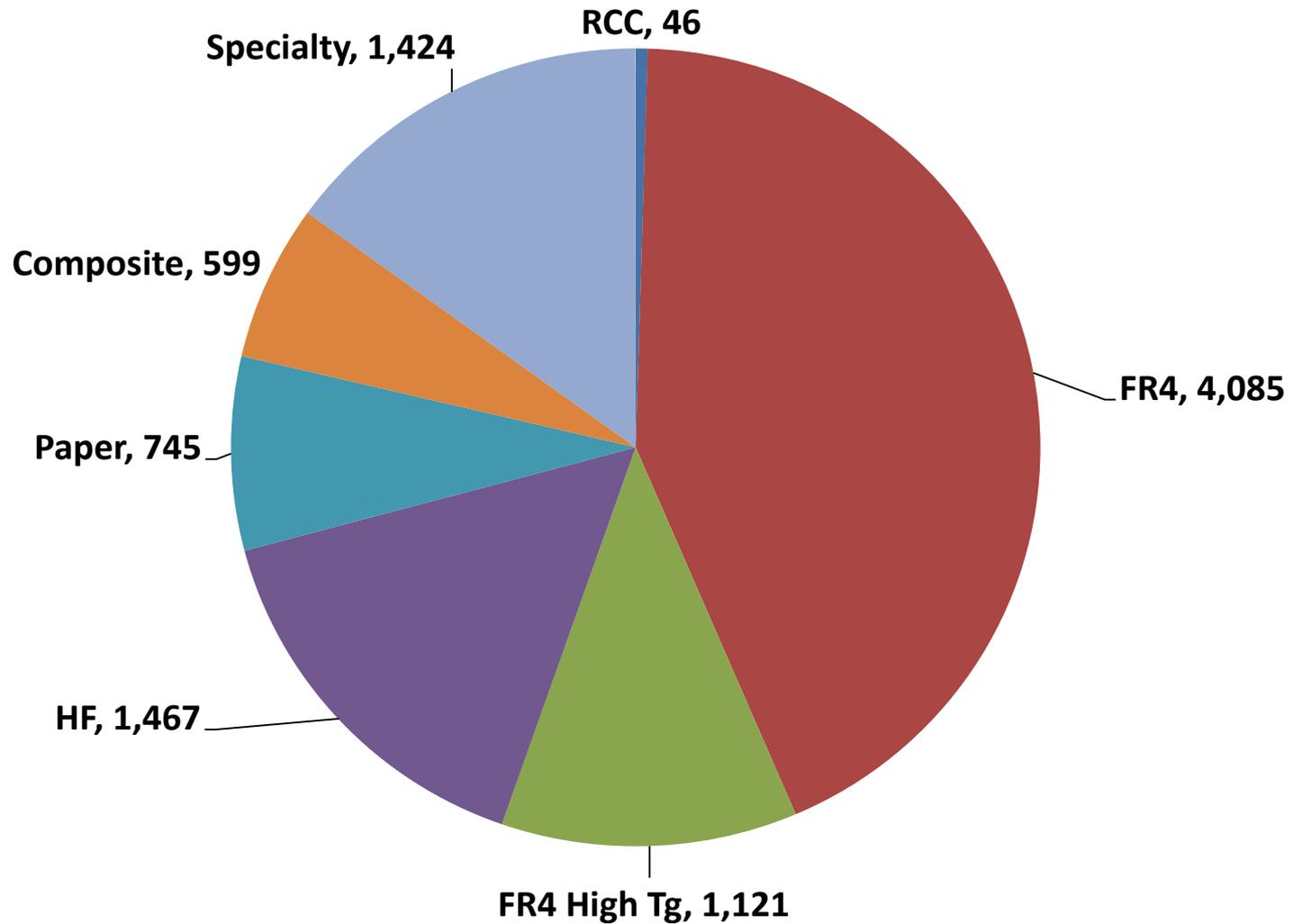
## ■ Key Attributes

- Homogeneous
- Low/no moisture pick up
- Chemically stable
- Thermally stable

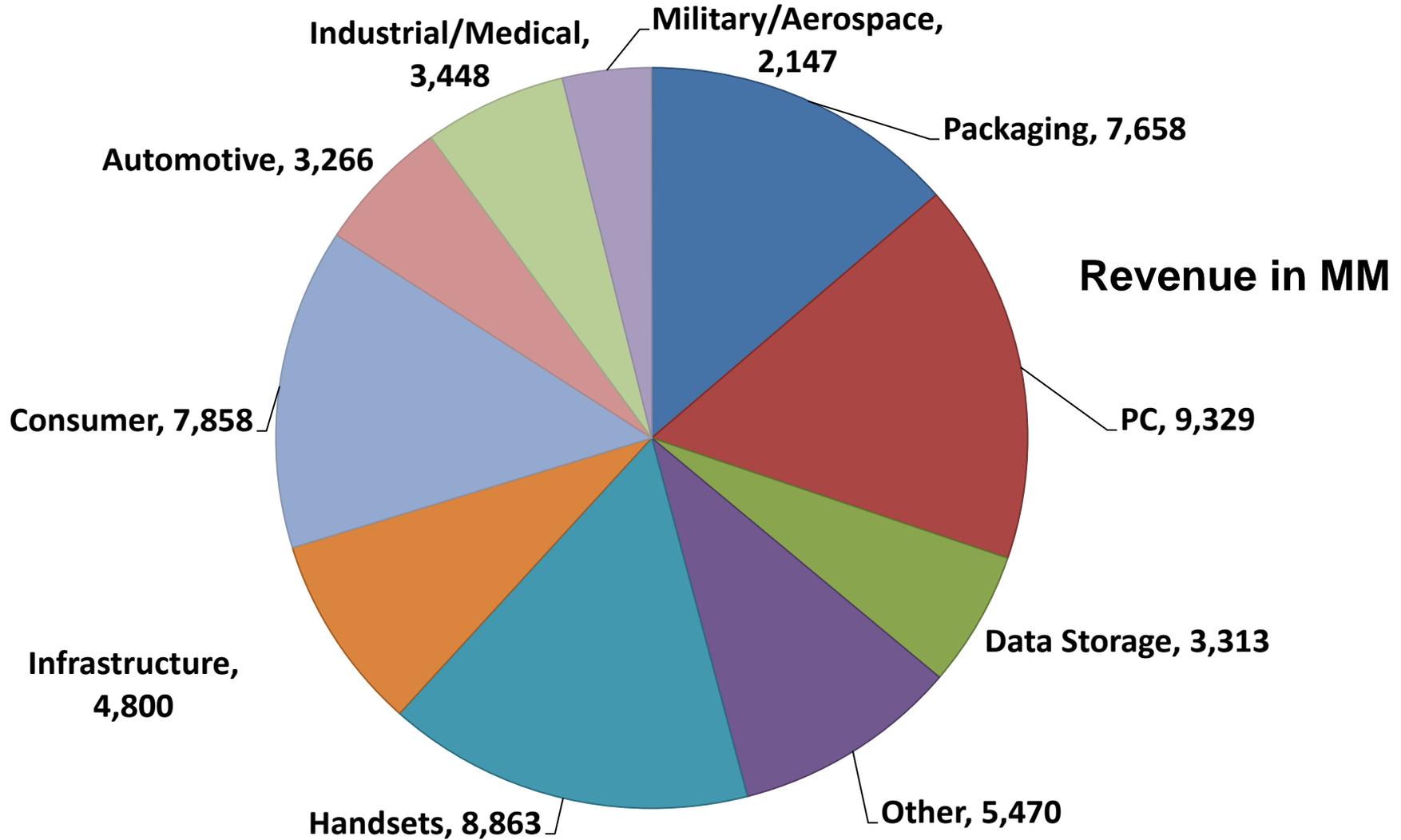


# Opportunities for FR in Electronics

# PWB Materials by Type



# PWB Materials by Application



# Growth Areas for HF PWBs

- **Computing and Office Equipment (~30%)**
  - PC, Tablets and Data Storage
- **Communication Electronics (~24%)**
  - Smart Phones, RF and Backplanes
- **Automotive (>7%?)**
  - Entertainment, Telematics, Hybrid Vehicles

