



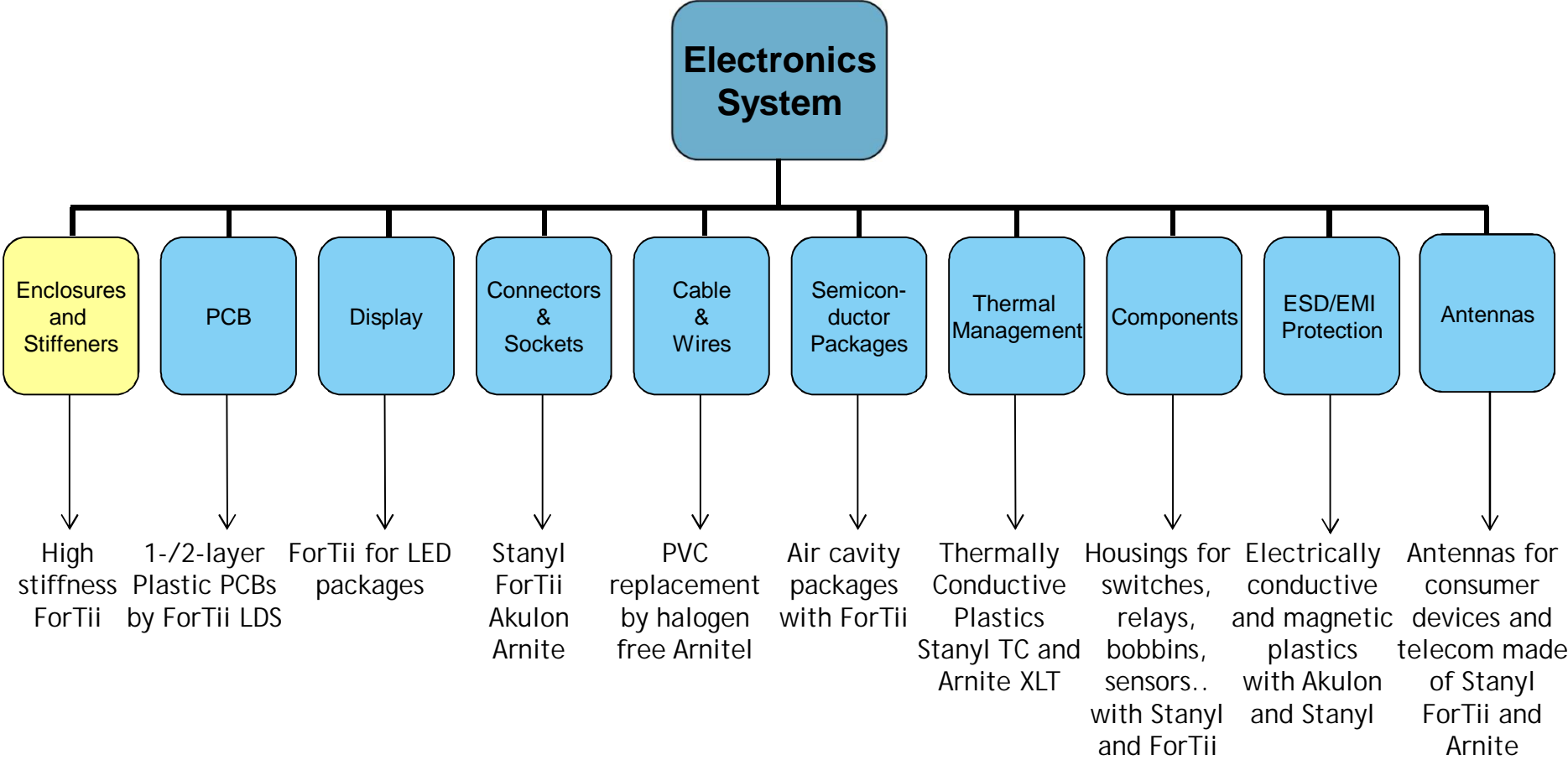
# DSM in Electronics

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Industry Segment Team Leader - Connector  
DSM Engineering Plastics

April 13<sup>th</sup> 2015

# DSM Application Coverage





# Stanyl ForTii in Enclosures/Stiffeners

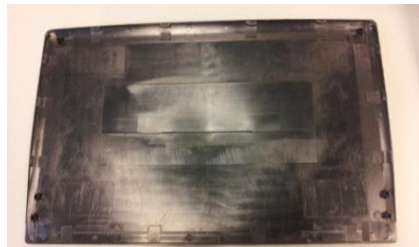
## Trend

- Continued move towards mobility
- ThInnovation
- Growing focus on sustainability



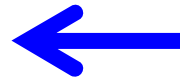
## Impact

- Reduction of wall thickness
- PC/ABS limited in flammability and stiffness @ thin walls
- Disruptive housings technologies (PAs, Al, Mg alloys,...)
- (New) recycling concepts



## Material needs

- High stiffness (>17GPa) materials @ good surface quality
- Impact resistance (e.a.b. >1.7%)
- Slow crystallizing plastics
- Halogen free UL94-V0 @ 0.8mm
- Low shrinkage, Good flow
- Good color ability of housing materials
- Nice surface appearance
- Low moisture absorption (RF transmission!)



## Application/Processing needs

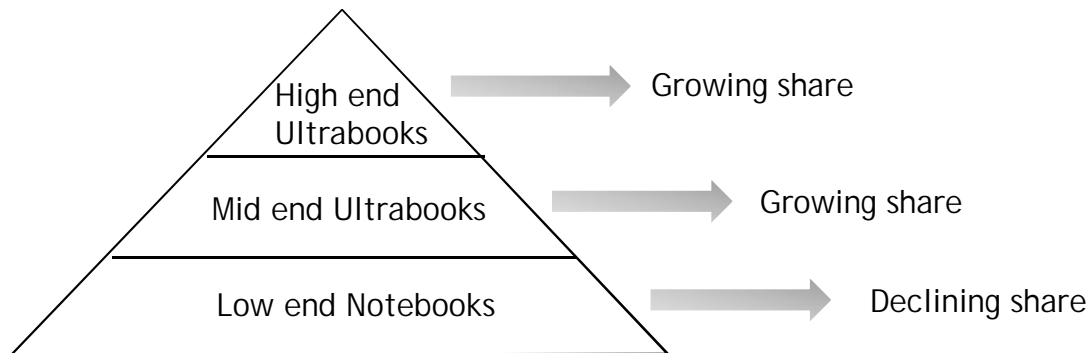
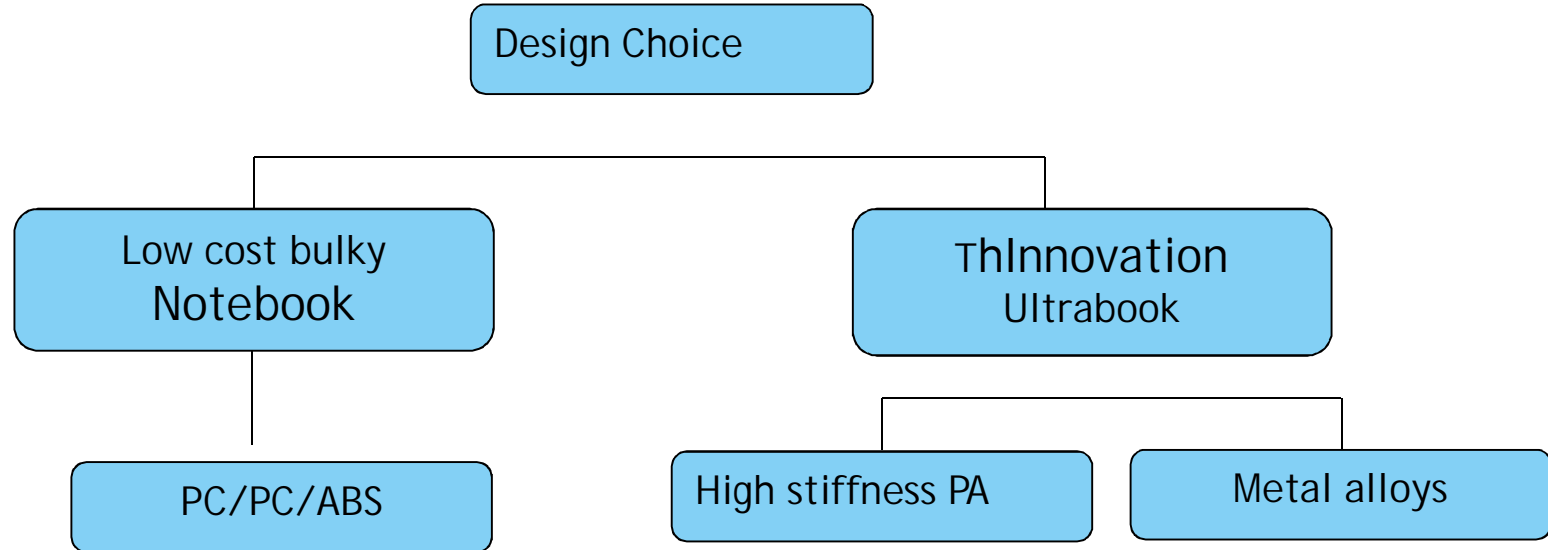
- High stiffness and impact
- Excellent coplanarity
- Good material processability especially with hot runner systems
- High esthetics of of housing materials

# Thin, Thinner, Thinnest

Structural components need high stiffness plastics or metals



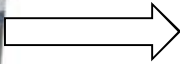
# Thin, Thinner, Thinnest



- Most Notebooks designed in PC/ABS
- Strong market trend is towards Ultrabooks
- Metal delivers perceived higher value, but comes at high production cost and lower manufacturing/design flexibility
- High stiffness PPAs deliver cost competitive solution, high design and manufacturing flexibility

# Ultrathin design with high reliability

Tumble Test



Typical PC or PC/ABS

Cycles passed: 175

→ >175tumbles frame cracks

DSM Stanyl ForTii XS81

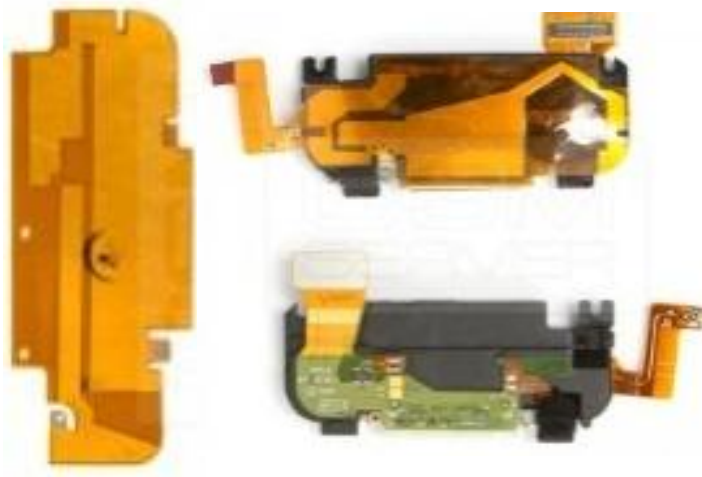
Cycles passed: 300

ForTii outperforms PC in stiffness and flexural strength: Stanyl ForTii is superior in tumble tests leading to higher end-product reliability

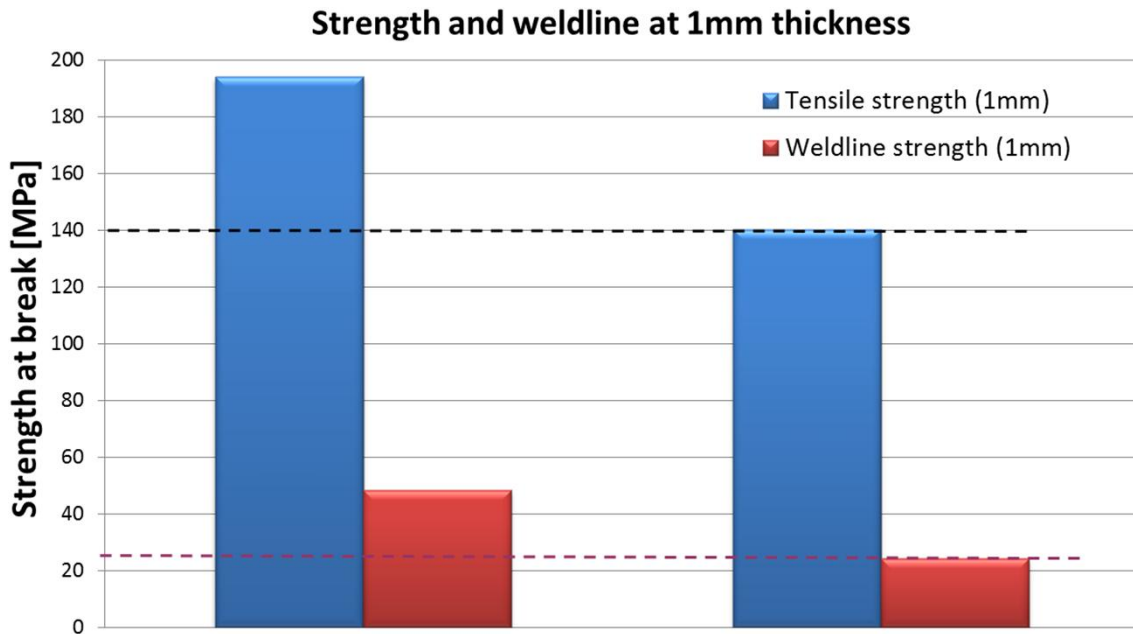
# Functional integration

Traditional FPC Antenna

LDS or Ag plated Antenna



# Weldline strength



DSM XS51 and XS81 series materials (Data from XS51)



DSM Stanyl ForTii

Passed drop height: 1.2m

Comp 01 PPA material



Competing PPA

Passed drop height: 1.0m

→ >1.0m frame cracks

## Drop Test





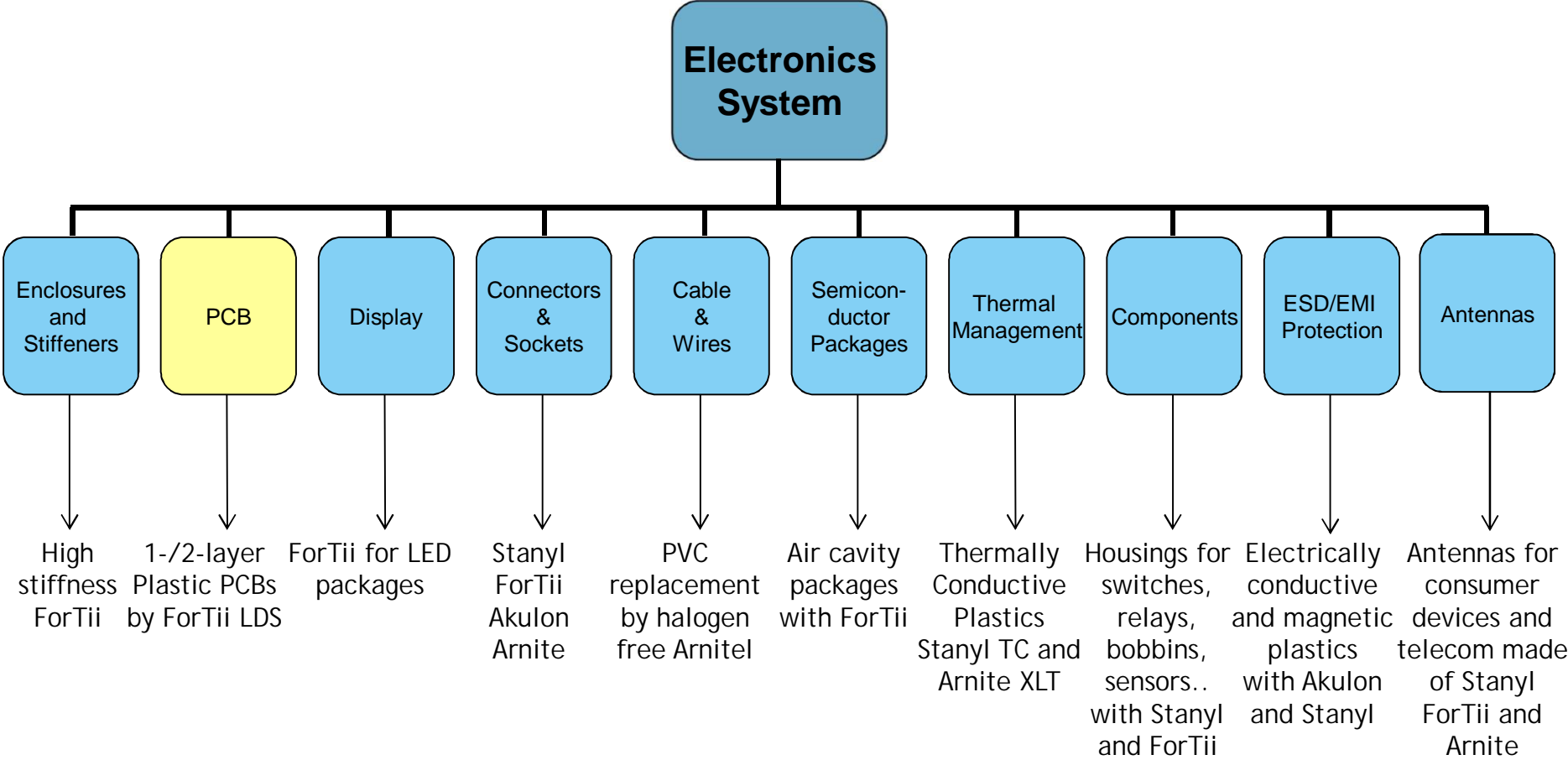
# Stanyl ForTii commercial at various OEMs

High stiffness Stanyl ForTii is being used by various OEMs in Consumer Electronics as replacement of Polycarbonate and outperforms alternative PPAs



Google Tango

# DSM Application Coverage



# DSM 3D-MID LDS solution

## Trend

- Continued move towards integration
- Growing content of electronics
- Demand for design flexibility



## Impact

- Integration of electronics in Housings and PCBs
- Easy functions such as electrical traces, interconnects, antennas integrated in plastics



1) Injection molded part



2) Lasere part

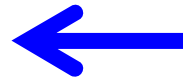


3) Plated part



## Material needs

- Lead free reflow solder ability
- Excellent plate ability
- Low warpage
- High mechanics
- Excellent application support
- Full portfolio available (UL94-V0, UL94-HB, impact modification)
- Halogen and red phosphorous free



## Application/Processing needs

- High stiffness and impact
- Excellent coplanarity
- Good material processability especially in platability
- Application support in product design

# DSM Lighting substrate solution

## Trend:

- Based on steep improvements in cost and efficiency, the overall operating cost of lighting in LED solutions is now outperforming traditional lighting technologies in several applications
- This results in an accelerated growth of LEDs in especially the professional segment

## Impact

- Players in the diversified and fragmented luminaire market need robust LED solutions which can be easily implemented. Preferably without introducing complex new production technologies



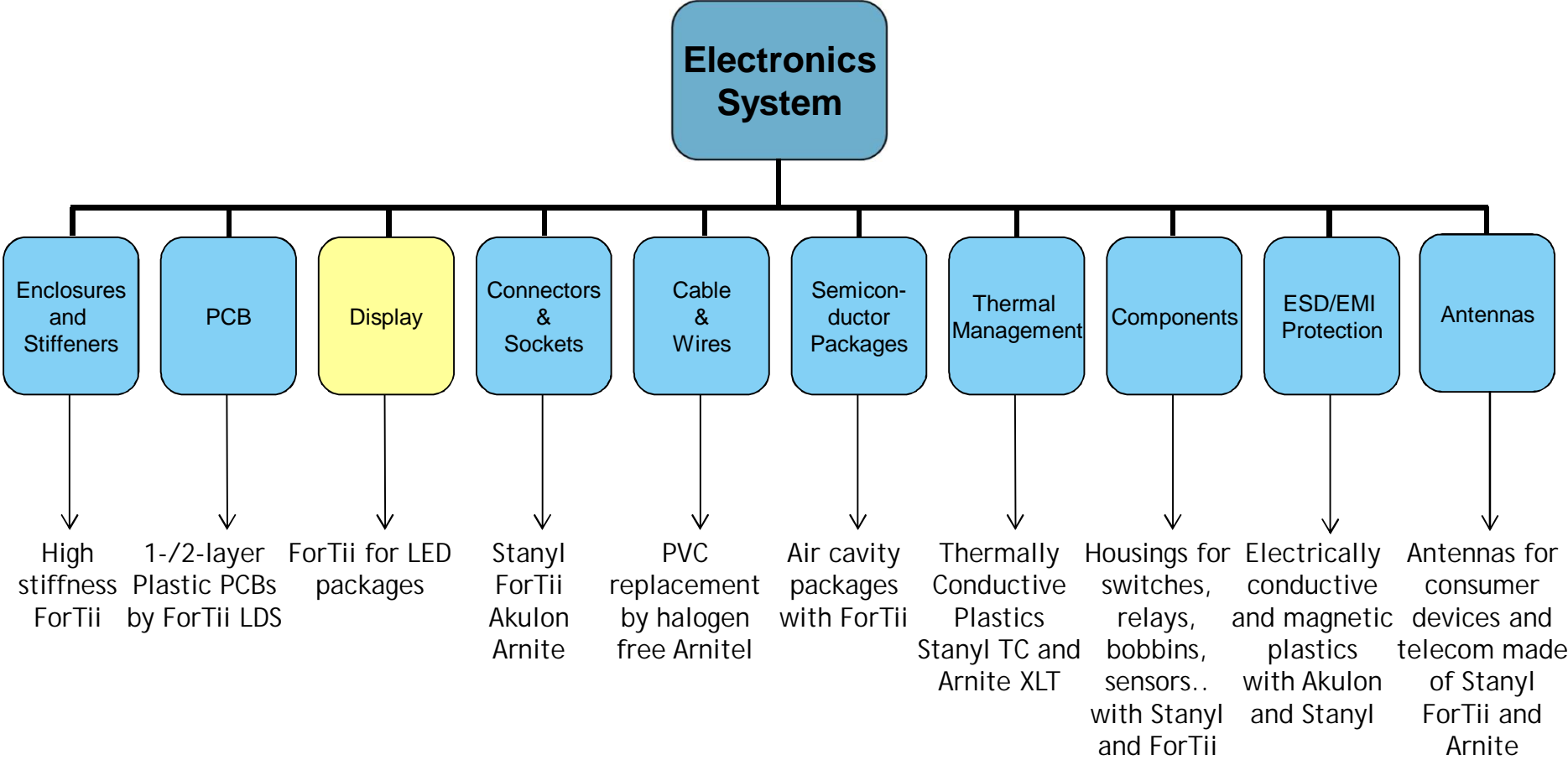
## Material needs

- Bright white color
- No discoloration in reflow soldering
- Excellent material flow to enable over moulding of thin parts
- UL V0 flammability at thin walls
- no halogenated flame retardants
- Excellent (weld line) strength
- Resistant to long term (thermal) aging (more than 50 000 h. lifetime)

## Application/Processing needs

- LED suppliers are offering “plug & play” LED arrays which can be easily integrated in LED luminaires
- Those units need to secure the mechanical, optical, electrical and thermal interfaces of the LED package

# DSM Application Coverage



# Stanyl ForTii in LED packages

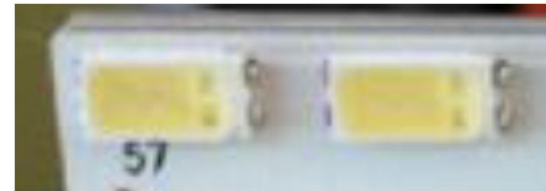
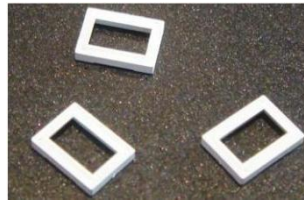
## Trend

- Growing focus on sustainability and ThInnovation
- Continued move towards higher LED output
- Continued trend towards higher power



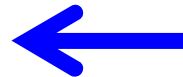
## Impact

- Higher power density of LED package
- Higher light exposure of LED package (especially blue and UVA)



## Material needs

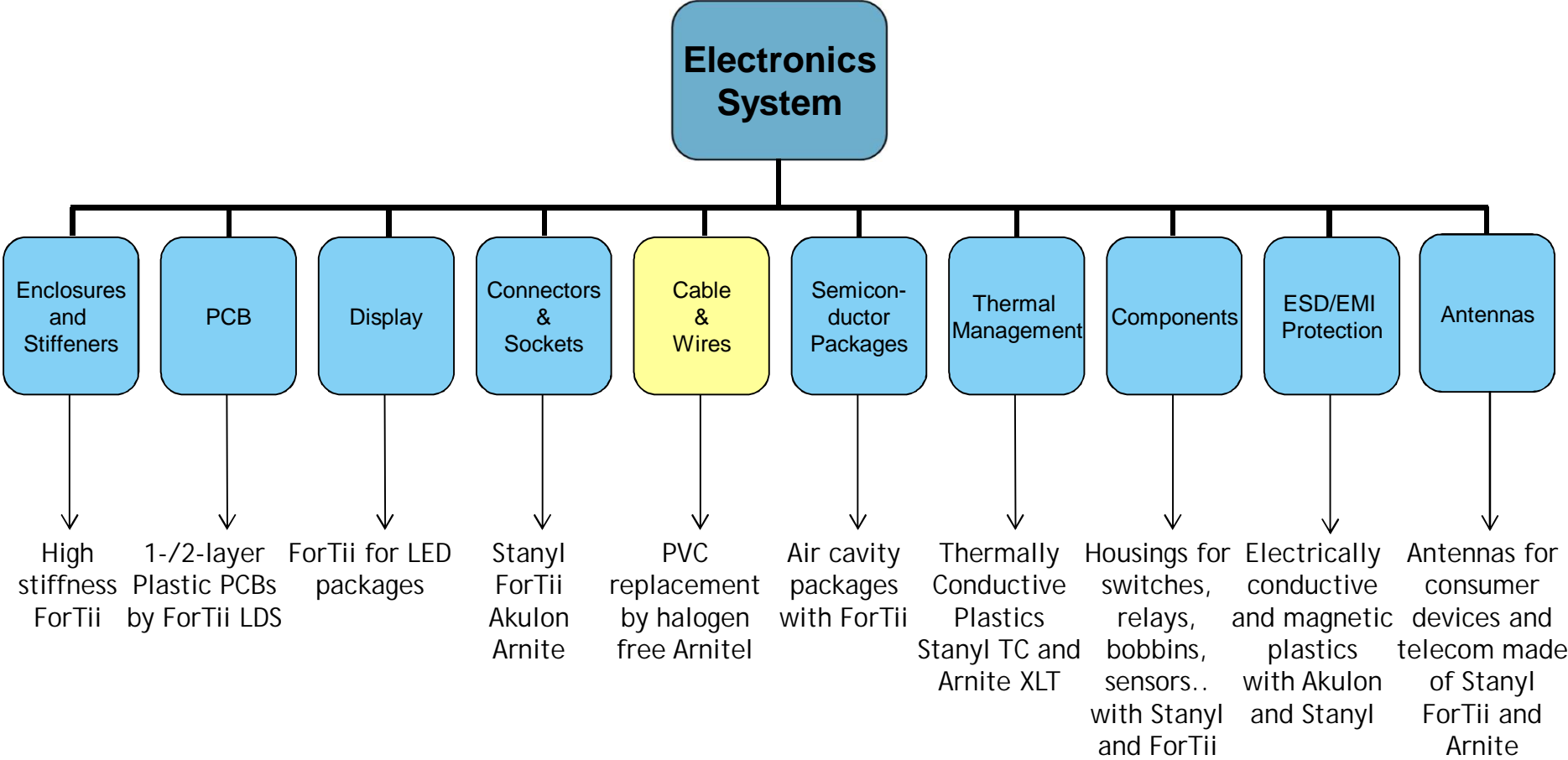
- High initial reflectivity (96-99%)
- Excellent whiteness retention in reliability testing
- Good adhesion to metals and encapsulation avoiding delamination
- High flow enables high cavity leadframe design and thin walls



## Application/Processing needs

- Materials of higher initial whiteness
- Material with improved whiteness (>96%) retention under high temperatures over long time (>3000h)
- Material with improved resistance under strong light irradiation (blue and UVA)

# DSM Application Coverage



# DC Charger Cord and Signal Cable

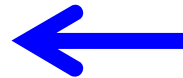
## Trend

- Replacing of PVC with cost competitive halogen-free TPE
- Touch and feel
- Bright colors
- Stain free
- Durability



## Material needs

- UL62 VW-1
- Halogen free plastics
- Plastics with high extrusion line speed
- Great surface finish
- Tough and flexible
- Chemical Resistance, especially Sebum
- Fully color ability



## Impact

- Increasing focus and regulation of hazardous materials
- Increased attention on cosmetics aspects of accessories
- Increased differentiation with colors



## Application/Processing needs

- Good quality cables
- Cost competitive cables
- Ease and efficient extrusion process
- Robust performance and perfect look, touch and feel
- Color differentiation



# Why Arnitel for Consumer Electronics

- Halogen-Free
- Excellent Chemical Resistance
- Stain Free
- Smell Neutral
- Excellent UV Resistance
- Can be Colored in any Colors
- Silky, good feel
- Magnetic Arnitel for noise cancellation

# Arnitel XG applications

- AC-Power cords 110V/220V insulation
- AC-Power cords 110V/220V jacketing
- MPM cable 5-20V insulation
- MPM cable 5-20V jacketing
- USB cables
- Low voltage charger cables



# Arnitel in high heat Applications

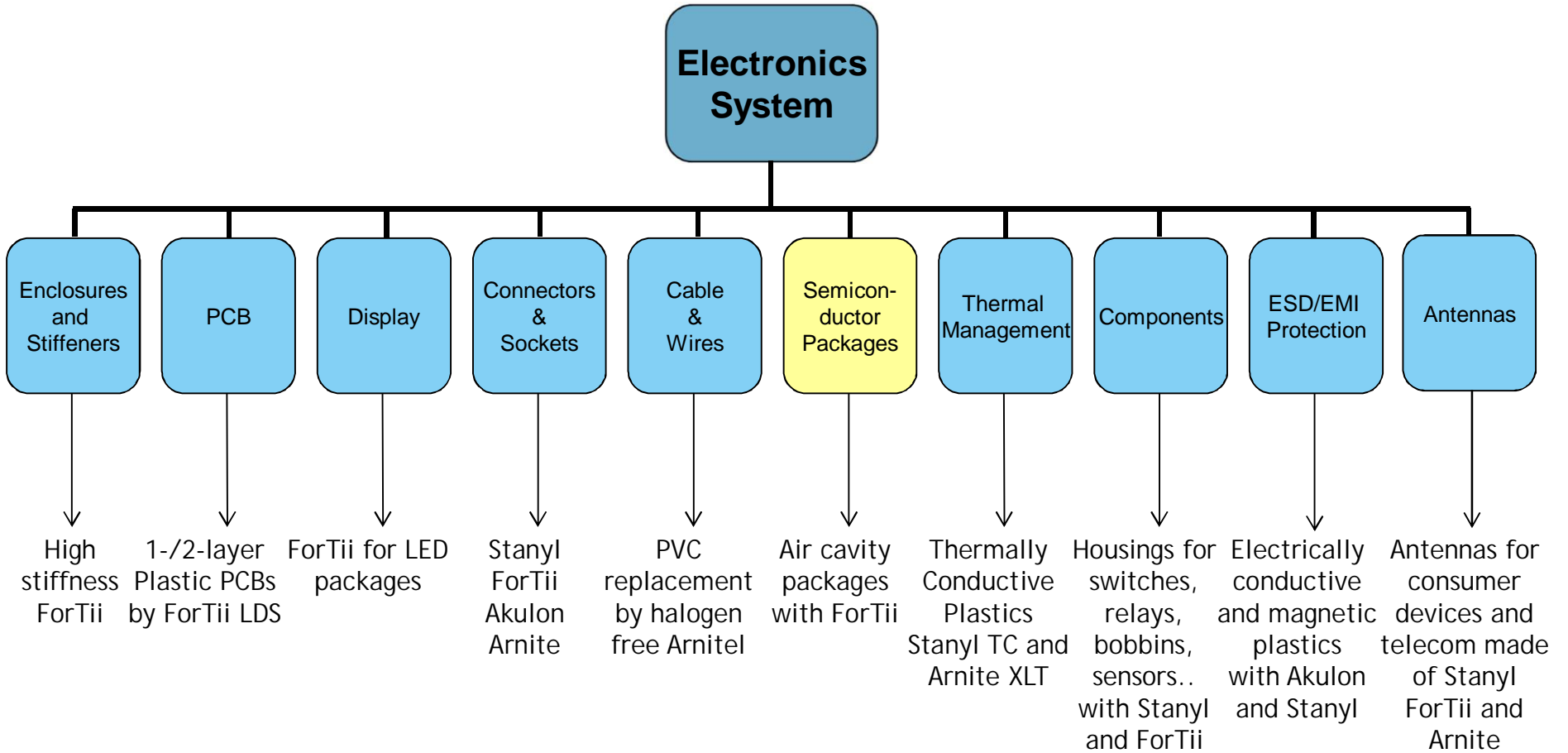
Arnitel U with CUT up to 150°C, Arnitel C with CUT up to 175°C



# Why Arnitel for Automotive Industry

- Halogen-Free
- Excellent Chemical Resistance
- Excellent UV Resistance
- High Heat up to 175C with Peak Temp of 200C
- Low Voltage, <1000kV

# DSM Application Coverage



# Stanyl ForTii in Semiconductor Packages

## Trend

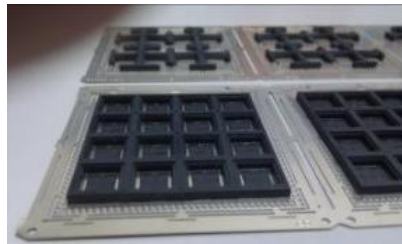
- Increased sensoric in electronics
- Increased integration of mechanics and electrics
- Miniturization



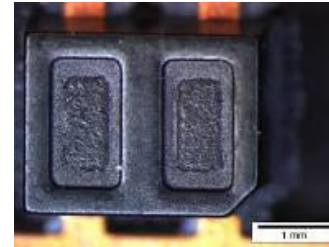
## Impact

- Increased amount of sensors
- Increased move to reflow soldering
- Increased demand for air cavity packages

Air cavity package for sensors

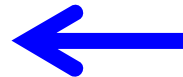


Proximity IR Sensor



## Material needs

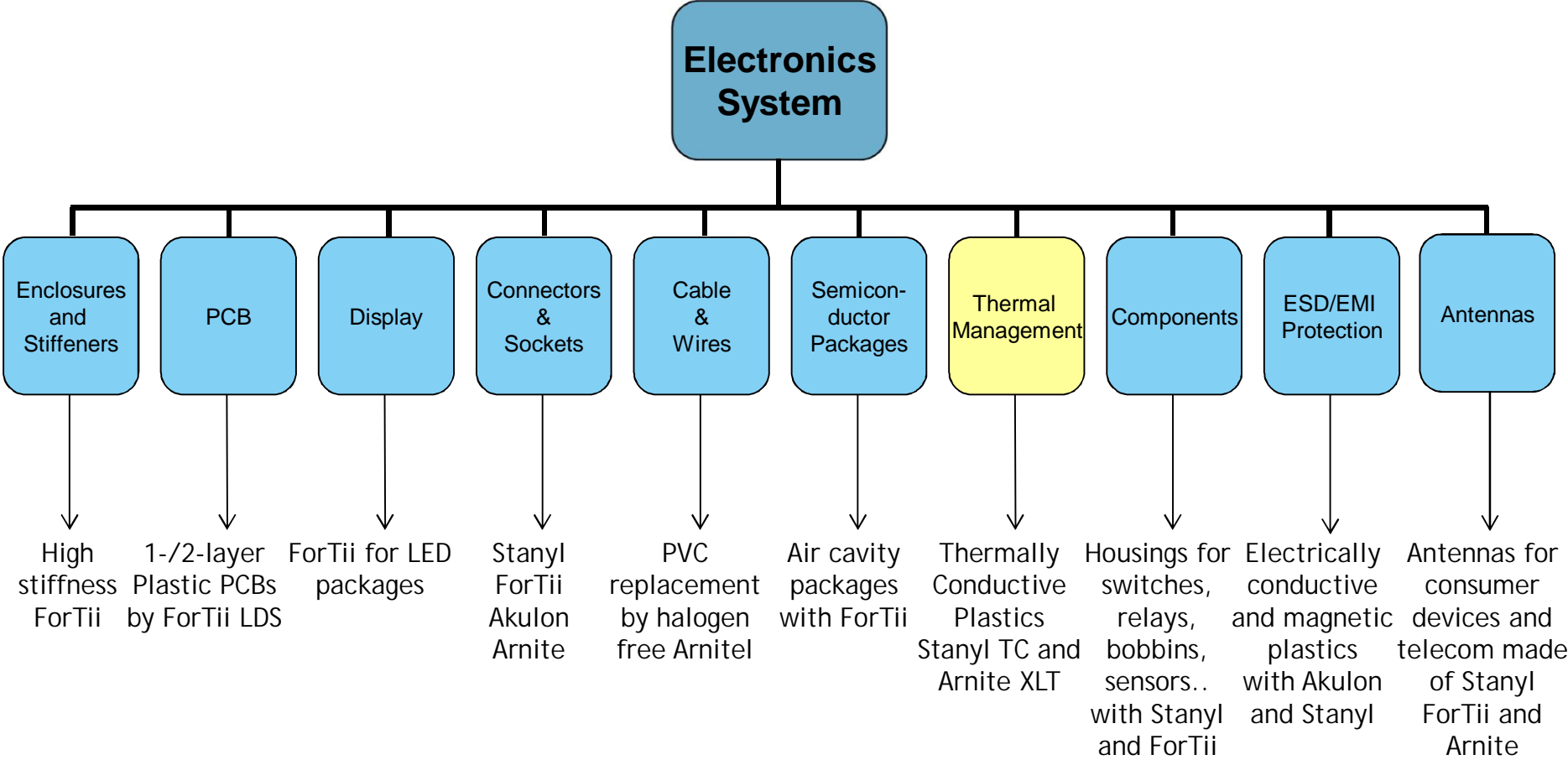
- Very low warpage due to high stiffness
- Excellent CTE match to PCBs
- Strong adhesion to metallic lead frame ensure good sealing without silicones
- Excellent block of light radiation
- UL94-V0, Entirely halogen and red phosphorous free



## Application/Processing needs

- High reliability and easy process ability
- Green materials
- Black color, blocking of light to avoid IC activation
- Reflow capable housings
- Mechanically robust designs

# DSM Application Coverage



# Stanyl TC for LED heatsinks

## Trend

- Based on steep improvements in cost and efficiency, the overall operating cost of lighting in LED solutions is now outperforming traditional lighting technologies in several applications
- This results in an accelerated growth of the LED industry



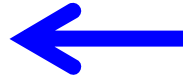
## Impact

- The LED lamp and luminaire industry is converting towards a high volume, low cost one
- The requirements for LED thermal management are decreasing, which enables the use of materials with lower thermal conductivity



## Material needs

- Good mechanical properties which enable integration of thermal and mechanical functionality
- Excellent flow to enable thin walls
- Good weld line strength to avoid cracks in overmoulded heatsinks
- UL certification with respect to flammability and thermal aging



## Application/Processing needs

- Need for high volume production technologies such as injection moulding
- Integration of functionality of functions in the light unit designs
- Overmoulding of metal heat spreaders

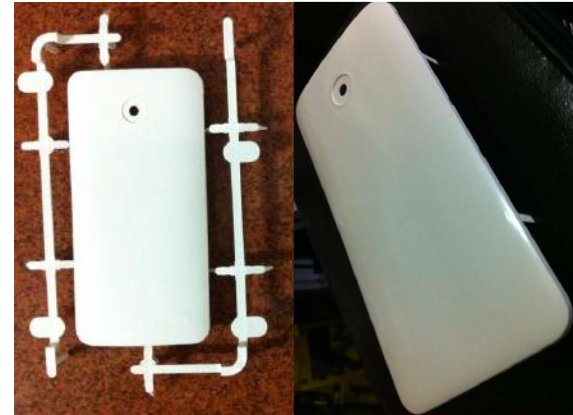


## Heat management is key

- The massive performance increase in Smartphone which is even outpacing the historic performance increase in PCs leads to heat management issues
- Current battery technology is pretty much at its limits unless breakthrough development. Size of mobile phones therefore is driven by larger battery which enable longer use times/additional features.
- Wireless charging spec Qi specifies 45°C as max. operation temperature for charging. Above 45°C wireless charging is shutting off.

# Thermally conductive enclosure

- Stanyl TC molded successfully
- Stanyl TC also used on HuaWei 4G WiFi
- Latest Innovation: TC + LDS in one material allowing heat management as well as electrical trace and antenna integration



Stanyl TC surface  
quality after molding

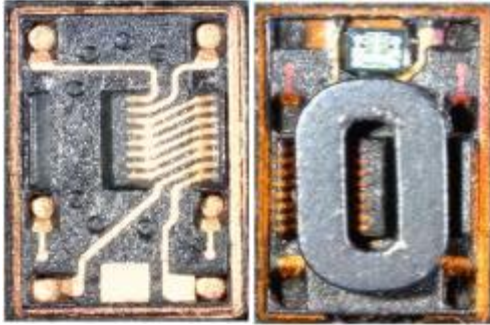
# Latest Innovations



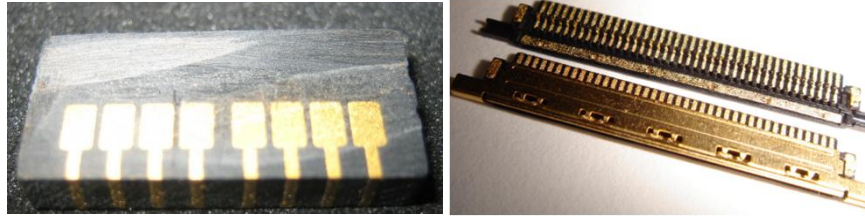
- LDS
- Silver Printing
- Magnetic Plastics

# Some LDS customer applications

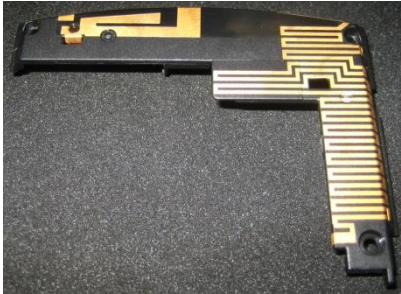
ESD/EMI component



Connectors



Mobile phone antenna



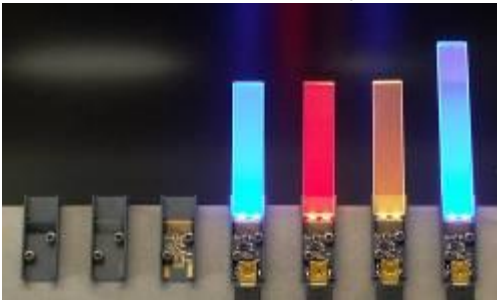
Coils



Notebook antenna



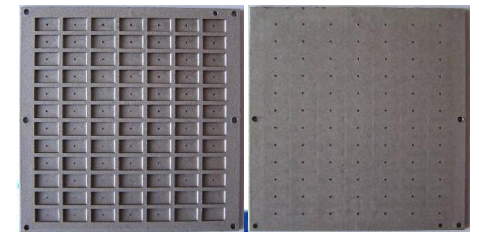
Optoelectronics system



Smartphone housing



EMI Shield



# 3D Silver Printing without plating bath



Molding



Printing of conductive ink



Sintering of conductive ink at elevated temperatures



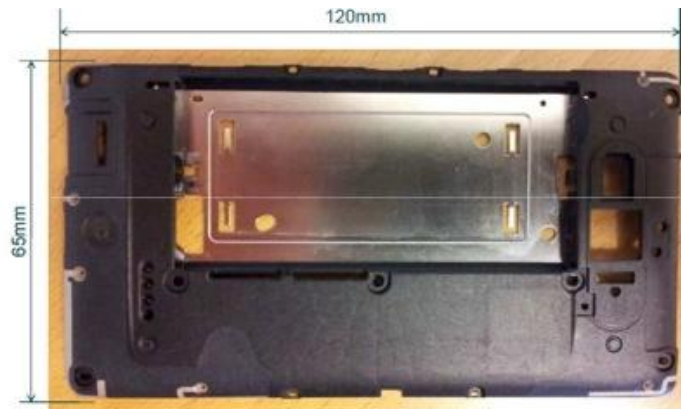
# 3D printing without plating bath

## Key features

- Fully 3D, Via printing possible
- Environmentally friendly (no more plating operations)
- Cost efficient (10-40% cost down compared to LDS)
- Cover layer about 5 micron, leading to serious reduction in paint cost
- Further integration of functional components with structural supports possible
- No more investments in either plating or lasers
- No more seed metal or inter-diffusion layers needed like Cu and/or Ni



3D printed antenna with ForTii DSP82, Ag layer 4 $\mu$ m, no Cu/N



ForTii DSP82 samples structural support with integrated antenna

# Plastic Magnetics

Inductors



DC/DC Converters



Drivers



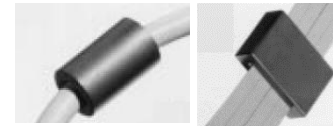
MagSafe



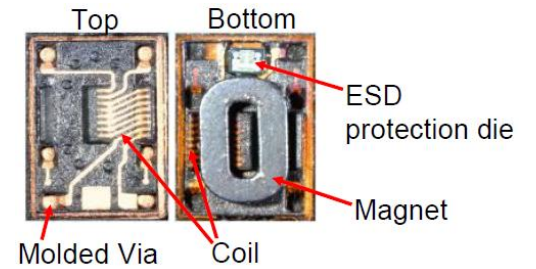
MagJack



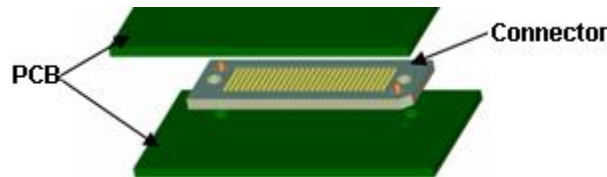
Coax and Ribbon cables



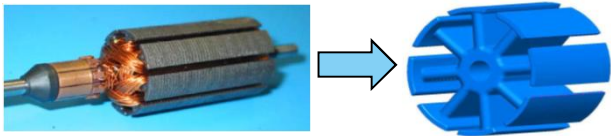
EMI shielding



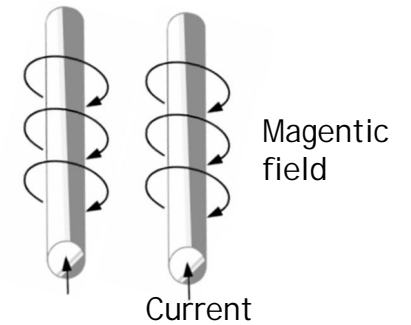
Impedance Matching



E-motors



Wireless charging



Cross Talk reduction

# Property profile of PBSMM at a glance

## Magnetic Properties

- Permeability  $\mu$  of 12 achieved (in polymer matrix)
- Saturation magnetization 0.2-0.8 Tesla achieved
- Electrical Conductive and Isolative Grades Available

## Processing / Manufacture

- Extrusion Possible
- Injection molding Possible
- LDS Possible

## Impact on Inductors

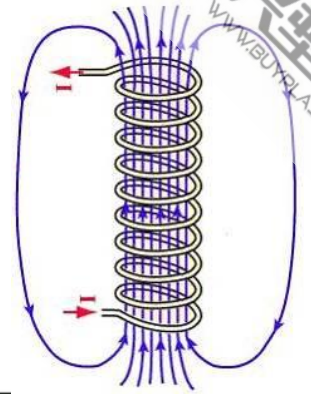
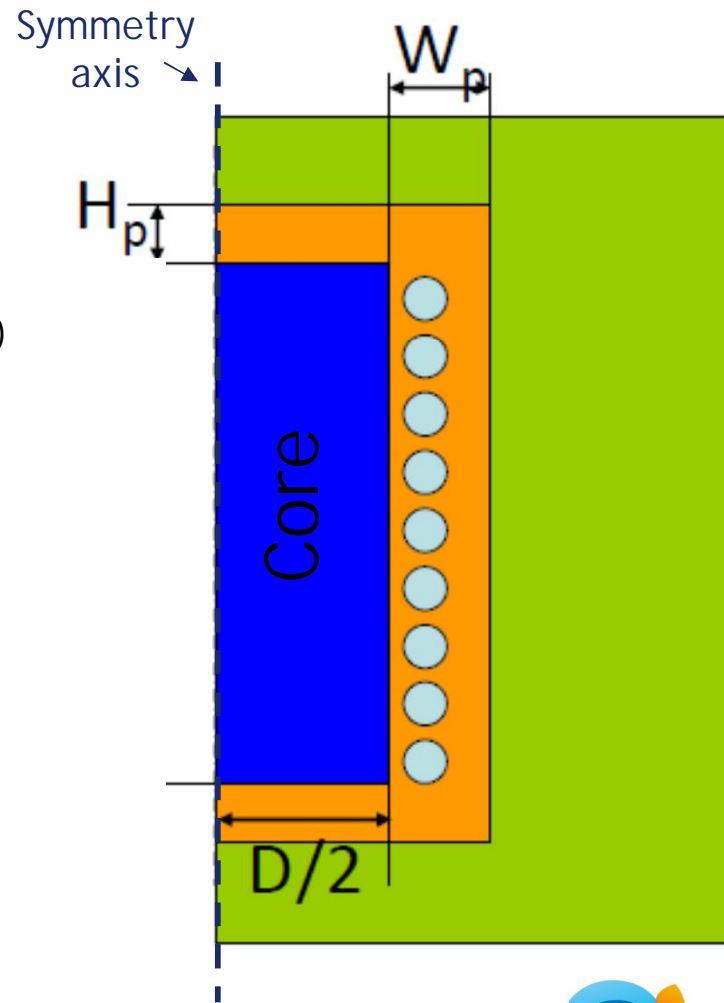
- Efficiency increase factor 4
- Effective magnetic shielding factor 2-3
- All plastic device feasible



# Modeling Inductor Efficiency

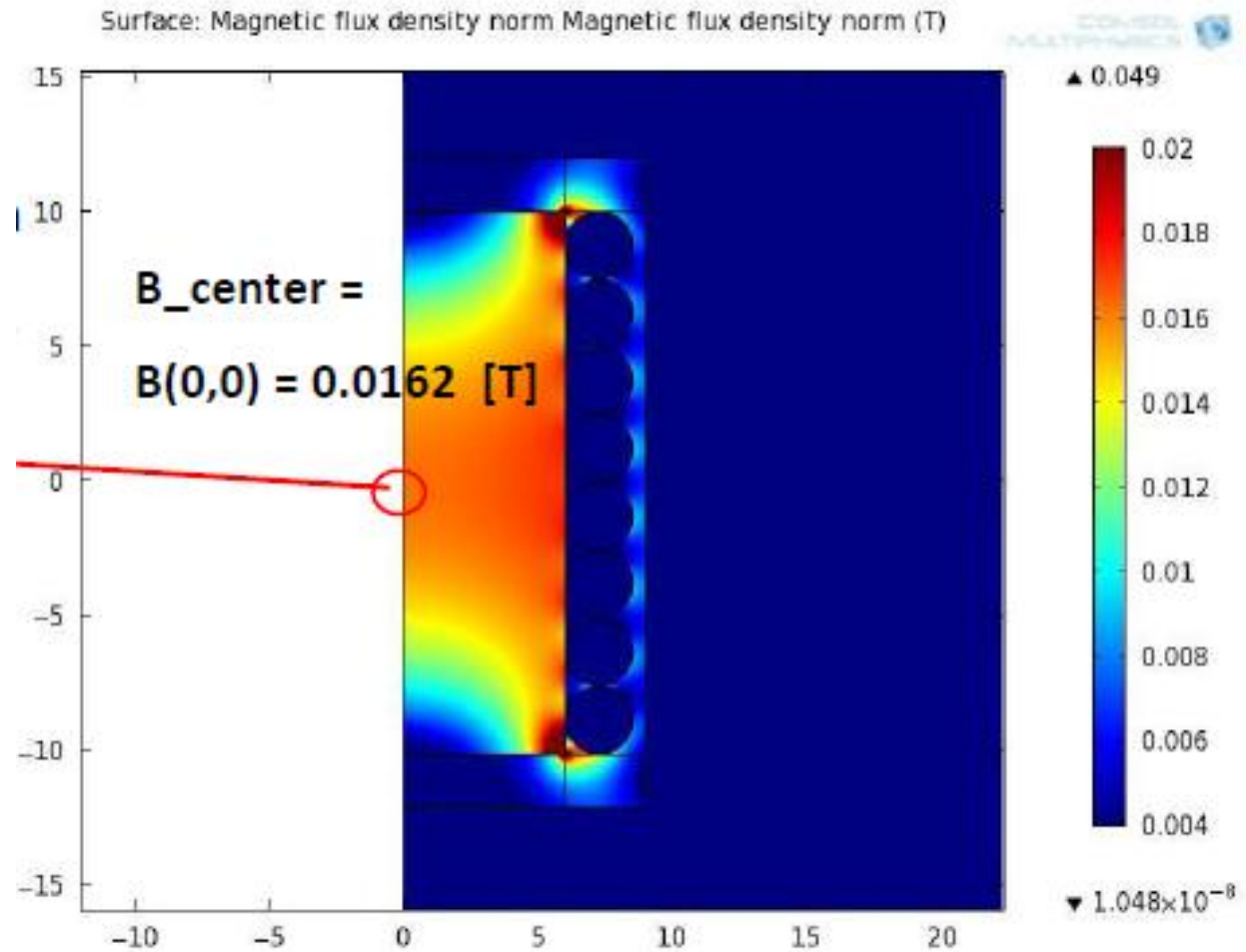
## Simple FEM model:

- Rotational symmetry  
(core cylinder:  $l = 20$  mm,  $D = 12$  mm)
- Core permeability:
  - 4000 (iron core)
  - $\mu_{r,plastic}$  (plastic core)
- Parameters:
  - $W_p$  = 0, 3, 4 mm
  - $H_p$  = 0, 2, 4 mm
  - $\mu_{r,plastic}$  = 1 - 4000



# Typical COMSOL Results

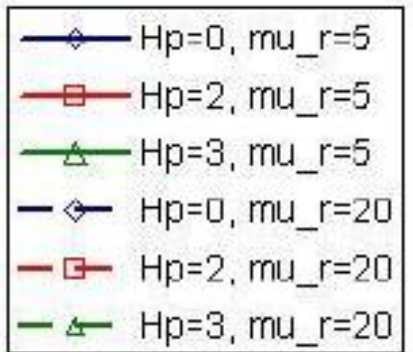
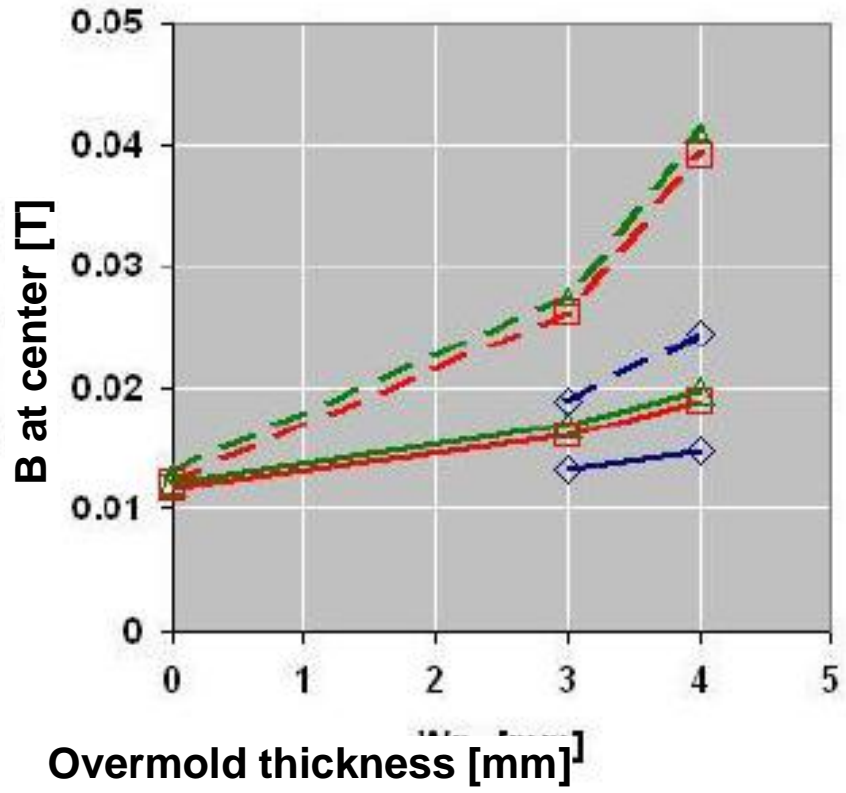
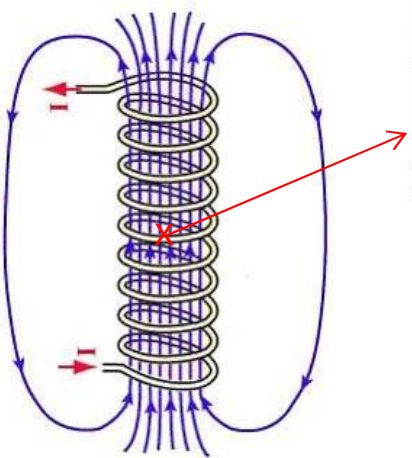
Used to assess device efficiency at fixed winding current



# Overmolding by PBSMM to increase efficiency

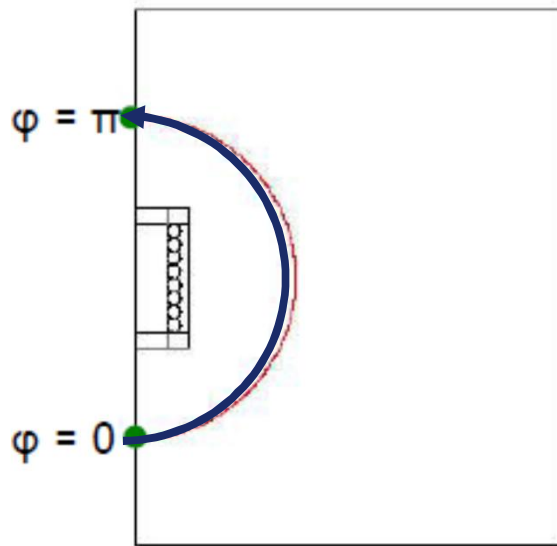
Increasing B-field (up to factor ~4) with:

- Increasing overmold thickness of PBSMM
- Magnetic permeability of PBSMM

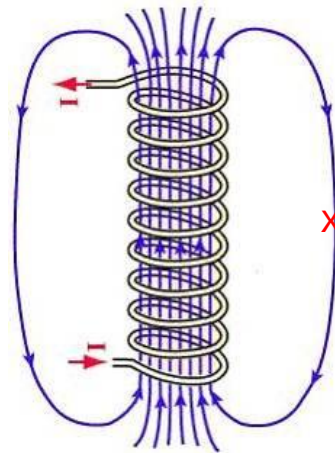


# Overmolding by PBSMM to shield magnetic fields

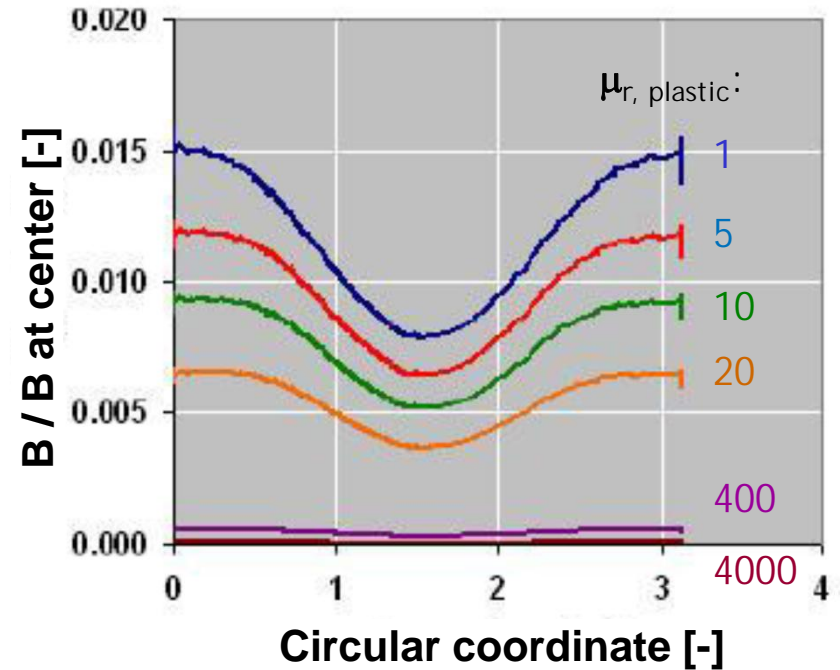
Evaluate field along:



Circle with radius of 30 mm



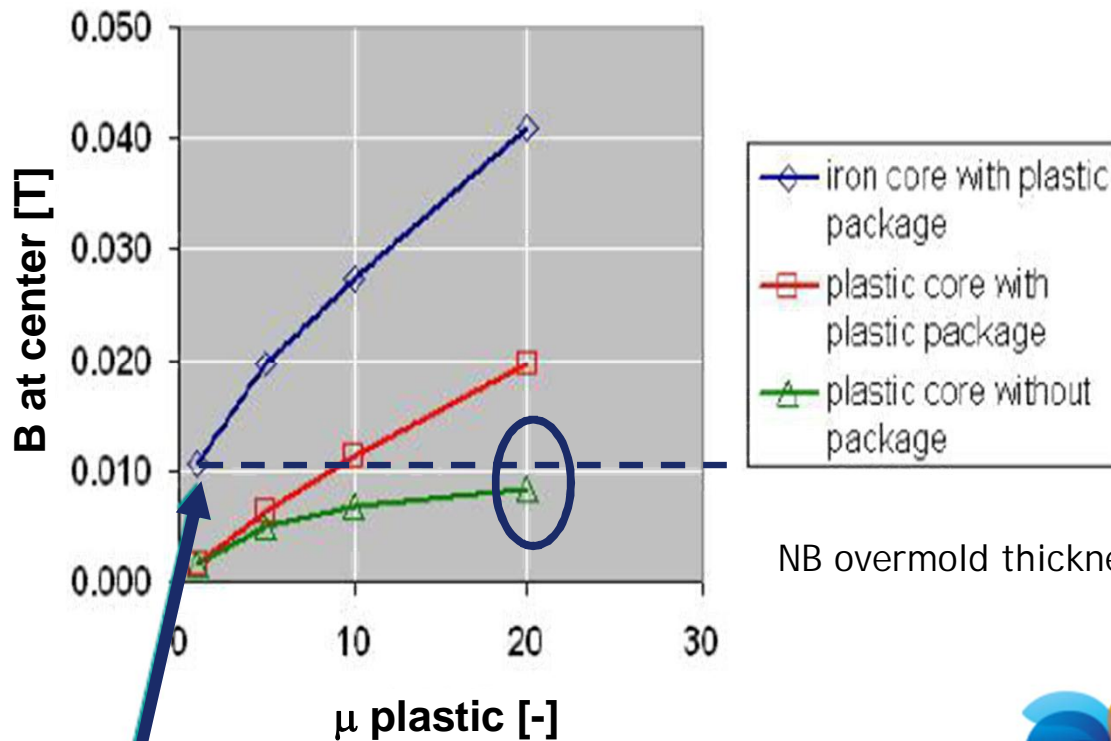
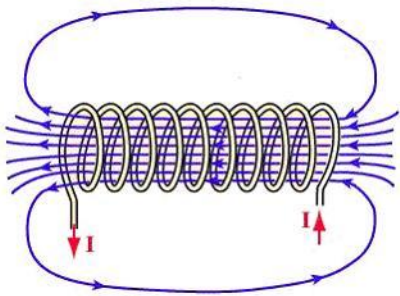
Shielding effect of factor 2-3 feasible for  $\mu_r = 20$



# All Plastic Inductors are Feasible

For  $\mu_r = 10 - 20$  simulations show:

1. All plastic inductor rivals iron-cored device without overmolding
2. Plastics core device shows decent performance even without overmolding!



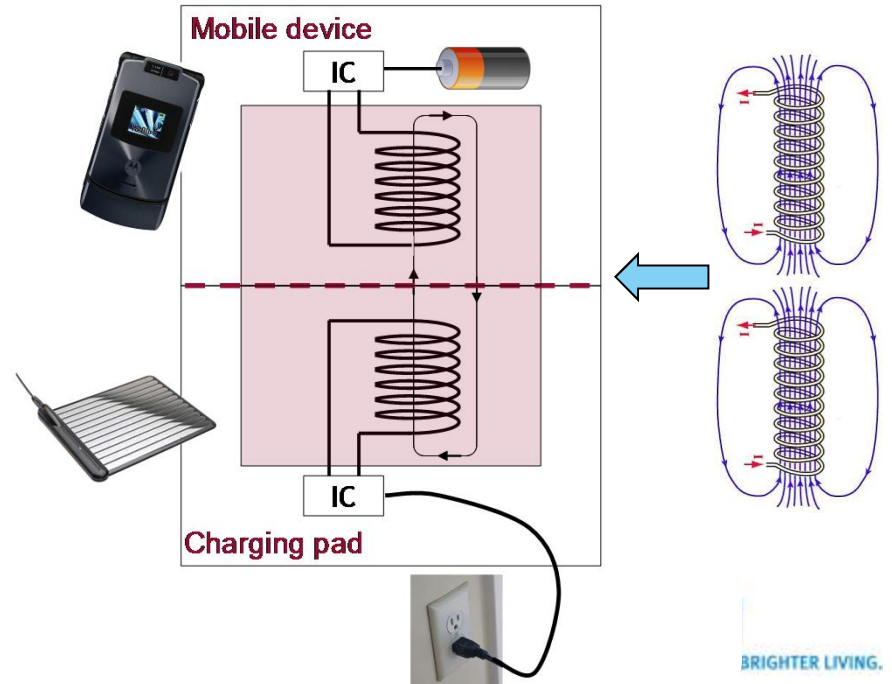
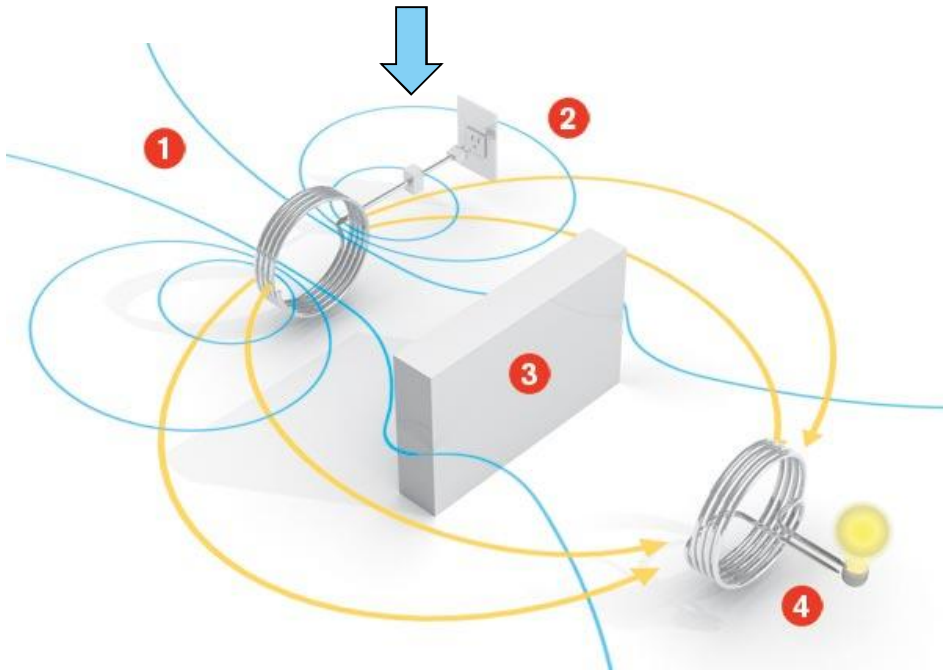
NB overmold thickness 4 mm

Iron core in air

# PBSMM to improve wireless charging efficiency



Wireless charging?



BRIGHT SCIENCE. BRIGHTER LIVING.™