CHEMISTRY THAT MATTERS™

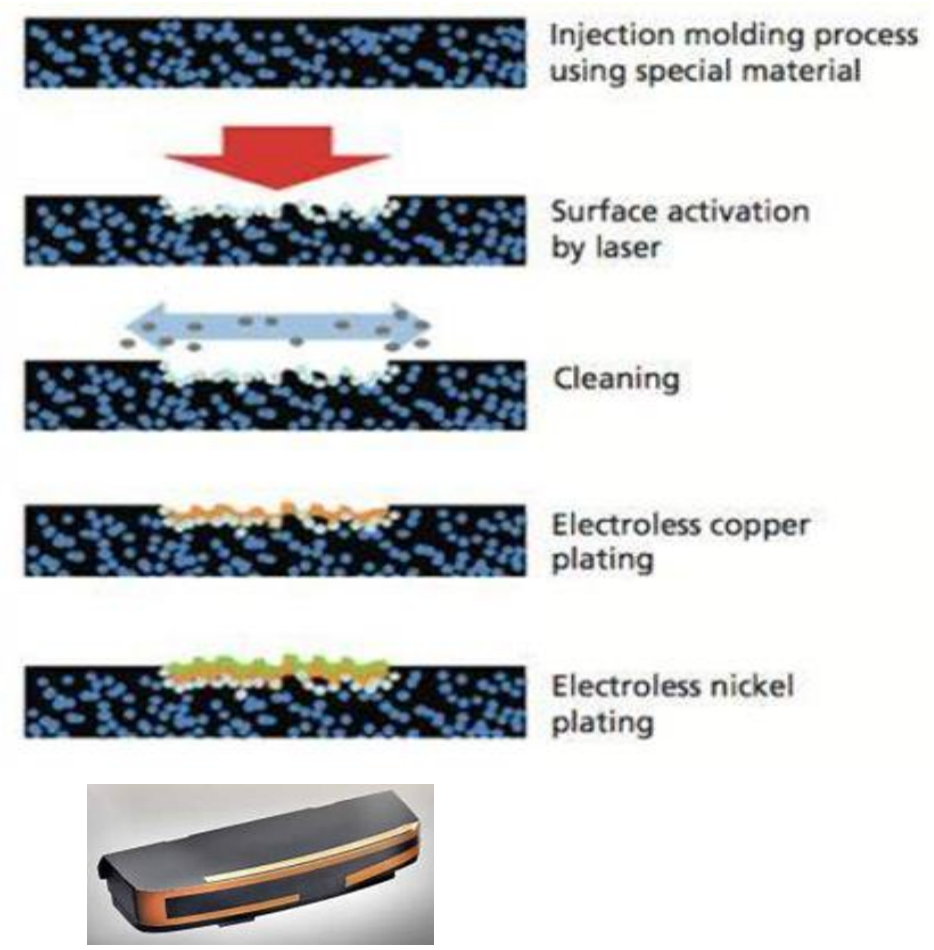
AN INTRODUCTION OF LNP™ LDS SOLUTION

NOV 2022

CONTENT

- LDS Basic Introduction
- LNP™ LDS Product Portfolio Introduction & Features
- The Introduction of Newly Commercialized LDS Grades
- LDS Recommended Processing Guideline
- Case Study

LDS BASIC CONCEPT



Selective metallization of thermoplastics injection molded parts by Laser Direct Structuring

LPKF developed Molded Interconnect Device (MID) technology in 1997 as a laser-based procedure for the production of MIDs, called the LPKF-LDS† Process.

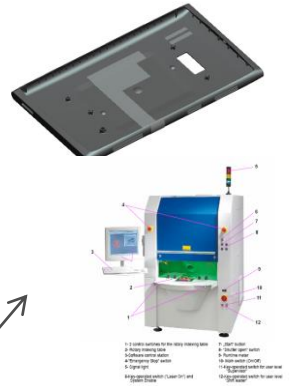
Benefits of LDS:

- Full 3D Capability – System Integration
- Fast and easy design changes – speed to market
- No layout specific tooling – lower cost
- Fine pitch resolution – miniaturization
- High cost efficiency - fine structure and small production

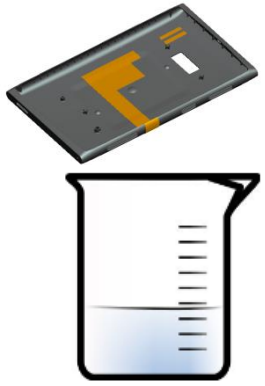
LDS BASIC PROCESS

Material Selection

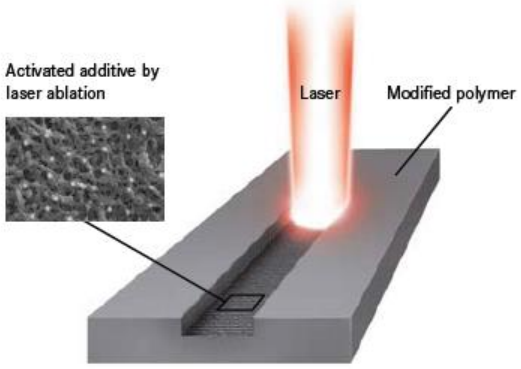
Part Molding



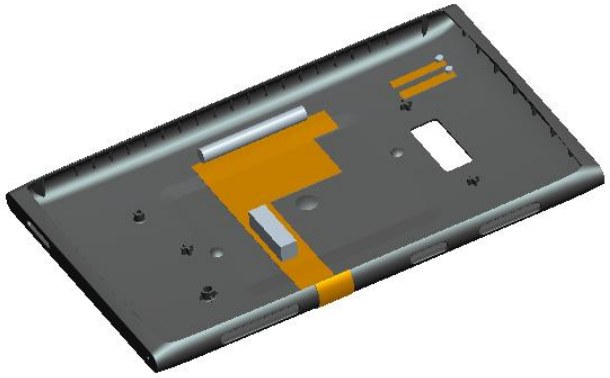
Laser Activation



Metallization



Laser Activation

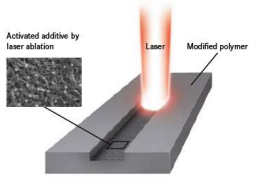


Assembly

LDS PROCESS INTRODUCTION

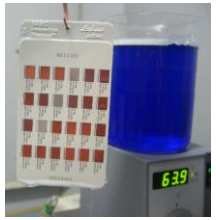
Part Molding

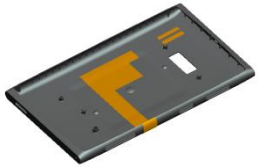
LNP™ THERMOCOMP™ compound for LDS shows good processability. The parts to be laser structured are produced first by single shot injection molding. To achieve good part performance, following the processing guidelines is highly recommended



Laser Activation

The special additive in the thermoplastic is activated by the laser energy. The formed metallic nuclei on the part can act as a catalyst for next reductive copper plating step. The created microscopically rough surface is helpful for the adhesion between the copper and plastic part



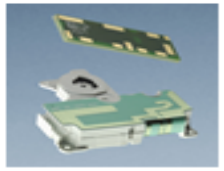
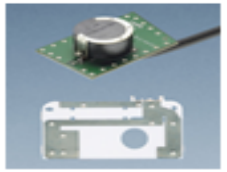


Metallization

The laser activated area is plated with metal layer by electroless process with the approved plating solvent and right process control. Some chemical companies develop the specified LDS plating process: copper layer build-up in the “Strike” and then “Build” electroless plating process. Ni and final finish is applied as well

LPKF LDS PROCESS VALUE PROPOSITION

Mobile Phone Antennas


	LDS MID	FPCB	SUS Stamping	2-shot MID
Material	LDS thermoplastic	PI film + PTFE + Cu	Steel + PC	PC + doped ABS
Strength	Fast design cycle, Consolidation design 3D design	Flexible Medium cost Stable RF	Low Cost Easy to change	Low cost Stable RF
Weakness	P&E investment Selective material	Only 2D capable Hard to change Selective material	Poor design efficiency High thickness	2K tool & machine Hard to change Selective material

Benefit

- 3D proto-typing and mass production
- Cost-efficiency via multi-MID integration
- More design space via various plating pattern, 3D design without additional tooling

LDS technology potentially provides cost and weight savings when integrated to housing

LNP™ THERMOCOMP™ LDS COMPOUNDS

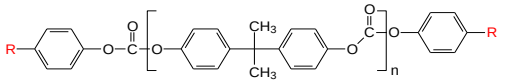
LNP™ LDS SOLUTION INTRODUCTION

Multiple Segment Needs

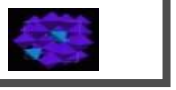
Design Freedom
3D and Fine Antenna
Short Design Cycle Time
Low System Cost
High Productivity
Environmentally Friendly
.....

LNP™ LDS Solution

Polymer



LDS additive / ...



Where may LDS Solution play?

- Antenna or antenna integration part for smart phone
- Antenna or antenna integration part for others handheld device
- Sensor inside circuit
- Automotive steering wheel inside circuit
- Hearing-aid 3D inside circuit
- Others electronic device inside circuit

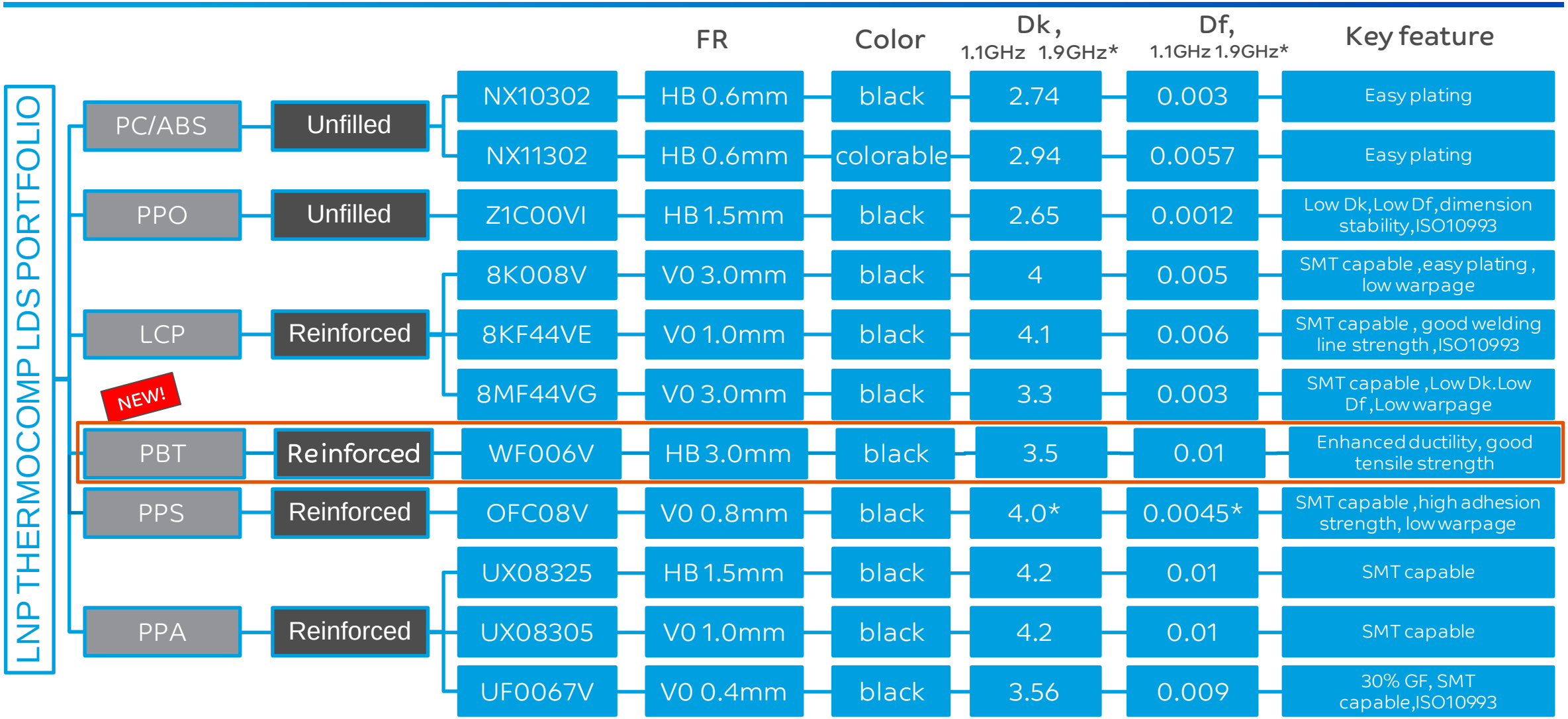
Value Propositions for Customer

- Integration for structure and functional part
- Complex and fine line design
- Thin wall design
- Wide color range
- System cost effective

LNP LDS Solution Helps Critical Antenna Design and Production

LNP™ THERMOCOMP™ LDS PORTFOLIO- 1

LNP™ THERMOCOMP™ LDS PORTOFOLIO BEYOND PC BASE



			FR	Color	Dk, 1.1GHz 1.9GHz*	Df, 1.1GHz 1.9GHz*	Key feature
PC/ABS	Unfilled	NX10302	HB 0.6mm	black	2.74	0.003	Easy plating
		NX11302	HB 0.6mm	colorable	2.94	0.0057	Easy plating
PPO	Unfilled	Z1C00VI	HB 1.5mm	black	2.65	0.0012	Low Dk,Low Df,dimension stability,ISO10993
LCP	Reinforced	8K008V	V0 3.0mm	black	4	0.005	SMT capable ,easy plating , low warpage
		8KF44VE	V0 1.0mm	black	4.1	0.006	SMT capable , good welding line strength ,ISO10993
		8MF44VG	V0 3.0mm	black	3.3	0.003	SMT capable ,Low Dk.Low Df ,Low warpage
PBT	Reinforced	WF006V	HB 3.0mm	black	3.5	0.01	Enhanced ductility, good tensile strength
PPS	Reinforced	OFC08V	V0 0.8mm	black	4.0*	0.0045*	SMT capable ,high adhesion strength, low warpage
PPA	Reinforced	UX08325	HB 1.5mm	black	4.2	0.01	SMT capable
		UX08305	V0 1.0mm	black	4.2	0.01	SMT capable
		UF0067V	V0 0.4mm	black	3.56	0.009	30% GF, SMT capable,ISO10993

LNP™ THERMOCOMP™ COMPOUND LDS GRADE DATA SHEET

LPKF Laser & Electronics

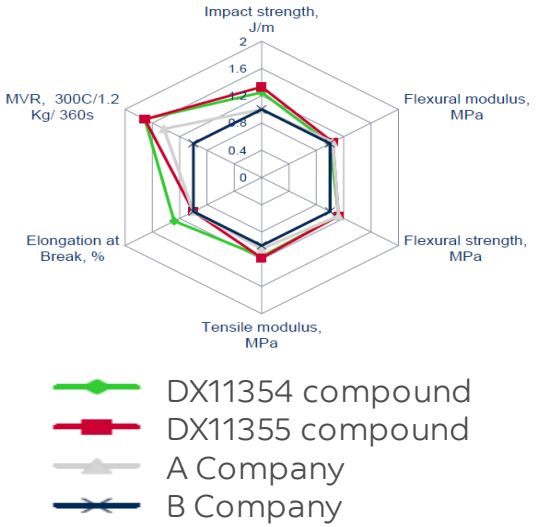
LNP THERMOCOMP Compound listed at LPKF†-LDS list

• DX11354 (PC)	BLK
• DX11354X (PC)	WHT
• DX11355 (PC)	BLK
• DX14354X (PC)	WHT
• D10001VR(PC)	BLK
• D10001VI(PC)	DIV
• D10006VR(PC)	BLK
• DF002FV(PC)	DIV
• DF002FVQ(PC)	BLK
• DF0041VI(PC)	BLK
• DF0061VI(PC)	BLK
• DX13354X(PC)	DIV
• DX15354(PC)	BLK
• NX10302 (PC/ABS)	BLK
• NX11302 (PC/ABS)	WHT
• UF0067V(PPA)	BLK
• UX08325 (PPA)	BLK
• UX08305 (PPA)	BLK
• Z1C00VI(PPO)	BLK
• 8K008V(LCP)	BLK
• 8KF44VE(LCP)	BLK
• 8MF44VG(LCP)	BLK
• OFC08V(PPS)	GYNAT

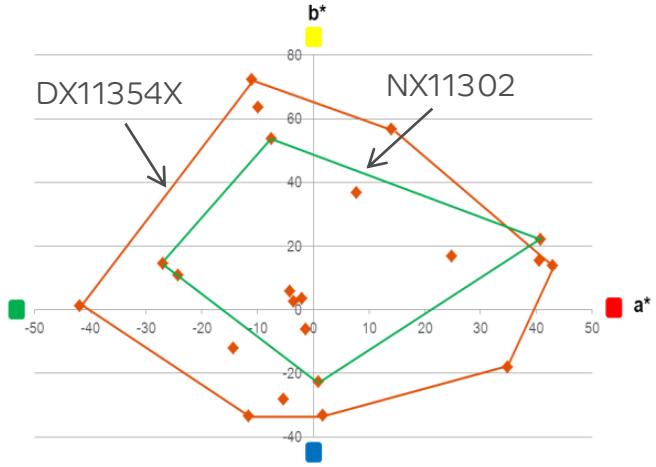
LNP™ THERMOCOMP™ LDS PORTFOLIO VALUE PROPOSITION

LNP THERMOCOMP LDS Compounds Can Provide:

- High flow with **superior impact performance** with UL94 V-0 rating down to 0.6 mm (PC base resin)
- **Wide color space** with patented technology
- **More complete portfolio**
- **Various Dk/Df LDS grades** for different applications requiring good dielectric properties
- High stiffness and modulus with **good aesthetics**
- High heat material for lead free soldering with **UL94 V-0 rating down to 0.4 mm**



Colorable LDS



Color space of NX11302 & DX11354X

LNP THERMOCOMP LDS compounds can deliver outstanding performance for many molded interconnect devices (MIDs)

THE INTRODUCTION OF NEWLY COMMERCIALIZED LDS GRADES

LNP™ THERMOCOMP™ D10001VP(ER008312) INTRODUCTION

LNP THERMOCOMP D10001VP(ER008312) is a PC based non-Chlorinated and non-Brominated FR UL94 V0 1.5mm for Laser Direct Structuring application

Features:

- Robust FR performance
- UL 746C F1
- High impact strength under low temperature
- Good process-ability
- UL94V0

Potential Applications:

- Outdoor application requiring UV exposure and water immersion
- Circuit replacement requiring fine pitch and 3D pattern
- Other applications requiring LDS capable, high impact , UL 746C F1 and UL94 V0

LNP™ THERMOCOMP™ 8K008V (ER010182) INTRODUCTION

LNP THERMOCOMP 8K008V(ER010182) is Liquid Crystalline Polymer (LCP) based compound for Laser Direct Structuring application

Features:

- High heat resistance for SMT processing
- Smooth surface
- Low Warpage
- Stable dielectric performance
- Easy plating
- UL94V0

Potential Applications:

- Optical communication module , 5G AAU dipole , OIS VCM , Antenna for laptop and wearable device , Endoscope antenna, POS security module

LNP™ THERMOCOMP™ 8MF44VE (ER010302) INTRODUCTION

LNP THERMOCOMP 8MF44VE (ER010302) is a Liquid Crystalline Polymer (LCP) based compound for Laser Direct Structuring application

Features:

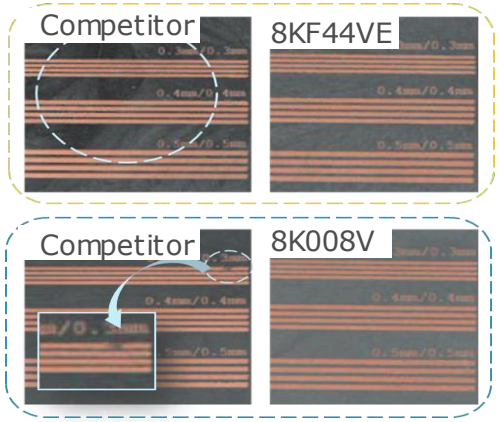
- High heat resistance for robust SMT processing
- High adhesion strength
- Good welding line strength
- Low warpage
- Easy plating
- UL94V0

Potential Applications:

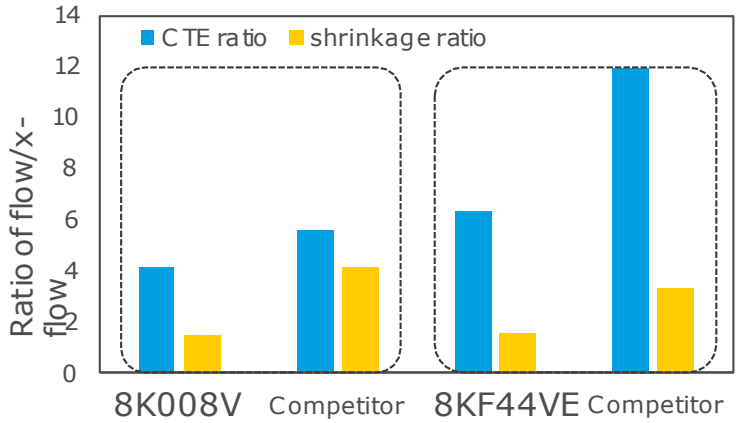
- Optical communication module, 5G AAU dipole , OIS VCM , Antenna for laptop and wearable device , Endoscope antenna, POS security module

LNP™ 8K008V/8KF44VE PERFORMANCE AND VALUE PROPOSITION

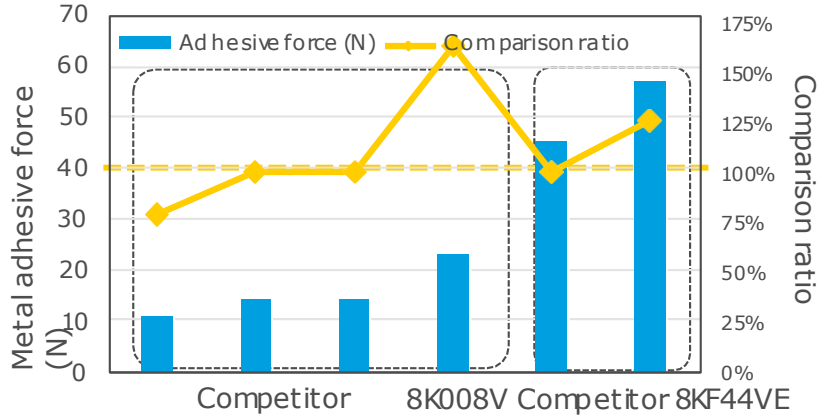
✓ Better surface & plating



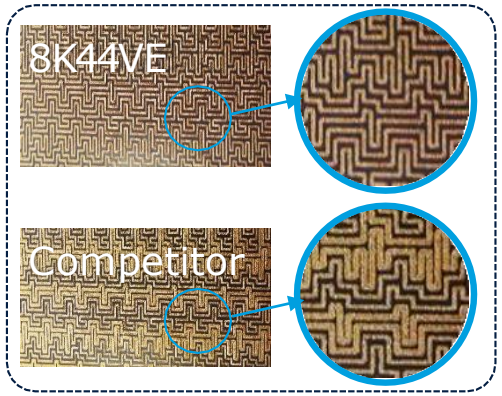
✓ Lower warpage



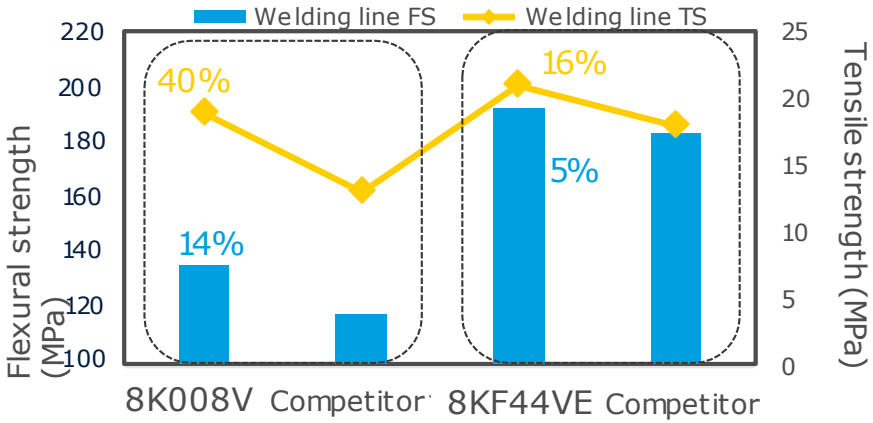
✓ Higher adhesive force



✓ Better overplating control



✓ Higher welding stregth



What we can bring :

- ✓ Better performance
- ✓ Bigger design space
- ✓ Higher efficiency
- ✓ Higher yield

LNP™ THERMOCOMP™ 8MF44VG (ER010710) INTRODUCTION

LNP THERMOCOMP 8MF44VG (ER010710) is a Liquid Crystalline Polymer (LCP) based compound for Laser Direct Structuring application

Features:

- High heat resistance for robust SMT processing
- Smooth surface
- DK 3.2 / Df 0.003
- Low warpage
- UL94 V0

Potential Applications:

- Laptop antenna is requested low Dk and Low Df , SMT capable , LDS , High flow , and Halogen FR V0
- Wearable device antenna

LNP™ THERMOCOMP™ OFC08V (ER011248) INTRODUCTION

LNP THERMOCOMP OFC08V (ER011248) is a PPS based with glass fiber reinforced compound for Laser Direct Structuring application

Features:

- High heat resistance for SMT processing
- High modulus and strength
- Good impact strength and ductility
- Excellent heat and chemical resistance
- UL94 V0
- Good flash control

Potential Applications:

- 5G dipole antenna ,Electric and electronic components , and various parts requiring high strength and high heat resistance

LNP™ THERMOCOMP™ DX11355RC(ER009131) INTRODUCTION

NEW!

LNP THERMOCOMP DX11355RC(ER009131) compound is based on recycled Polycarbonate (PC) resin. Added features of this grade include: Good Surface, Good Ductility, Non-Brominated & Non-Chlorinated Flame Retardant. Post-Consumer Recycling (PCR) Polycarbonate content up to 50% for Laser Direct Structuring application

Features:

- Flame retardant
- Post-Consumer Recycled (PCR)
- Non-Brominated, Non-Chlorinated
- Laser Direct Structuring

Potential Applications:

- Personal accessory
- Electrical devices and displays, Electrical components and infrastructure

LNP™ THERMOCOMP™ WF006V (ER010941) INTRODUCTION

NEW!

LNP THERMOCOMP WF006V compound is a 30% glass fiber reinforced PBT resin based LDS material solution with good plating and stable RF performance. Wide processing window makes it a good candidate for internal and external parts for Laser Direct Structuring applications.

Features:

- Chemical Resistance
- High Heat Resistance
- Good Tensile Strength
- Enhanced Ductility
- Low warpage

Potential Applications:

- Smart phone antenna , Wearable device antenna, Animal tracker

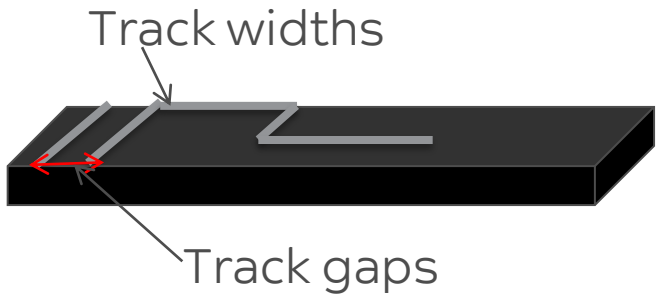
PROCESSING GUIDE

- DESIGN GUIDE & INJECTION TROUBLESHOOTING
- LASER ACTIVATION PLATING

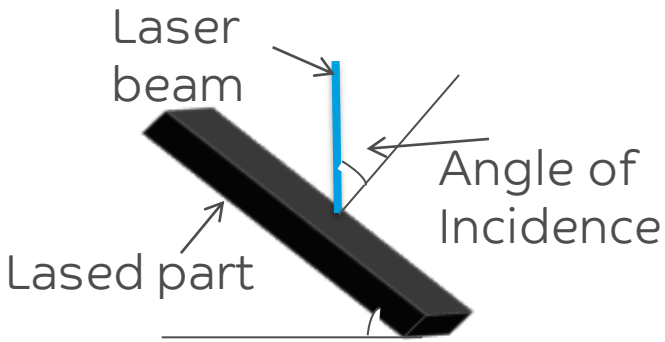
LDS DESIGN GUIDELINES (SUMMARY)

- Avoid using aluminum-based tool for LDS material injection
- Sharp edged transition around the metallization structure should be avoided
- Avoid injection point and ejector locating around the metallization area
- Avoid gate & weld line on metallization area
- Flow mark & gas trap should not be on metallization area.
- Silicon-based mold releasing agent should not be used during injection
- With GF filled grade, must follow general rules to minimize glass floating on surface
- Choose the optimal material based on the application and follow the processing guidelines
- Material recycling must be prevented

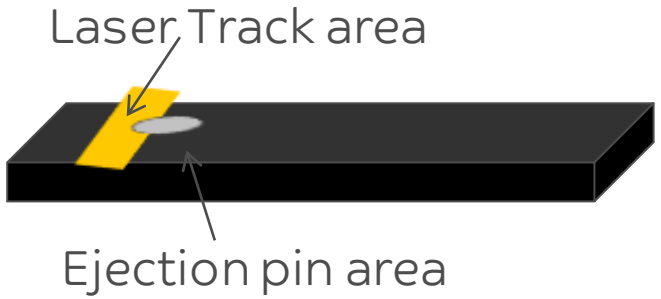
LDS DESIGN GUIDELINES



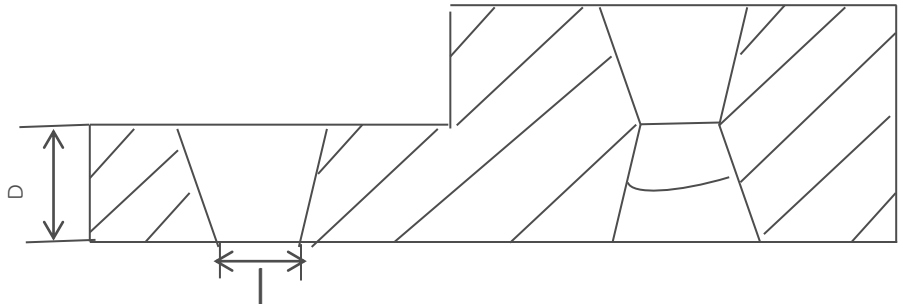
Laser track widths of ≥150 µm and gaps of ≥200 µm have proven to be ideal in practice, although thinner tracks and gaps are possible.



To make sure there is a good laser effect, the maximum angle of incidence of the laser beam must not exceed >70°.



An adequate separation between the tracks and ejection pins must be incorporated into the design.



The hole could also be lasered. To ensure the laser effect, the bias should be conical on one side or both sides depending on the thickness of the material.

TROUBLE SHOOTING

Possible Cause:
1: Excessive moisture in material
2: Excessive long pre-drying time
3: Excessive high melt temp

Possible Cause:
1: Small gate causes excessive shear
2: Cold material

Possible Cause:
1: Resin drying insufficiently

Possible Cause:
1: Tool high melt temp
2: Long residence in barrel
3: Production interrupted without reducing temp

LASER ACTIVATION PLATING

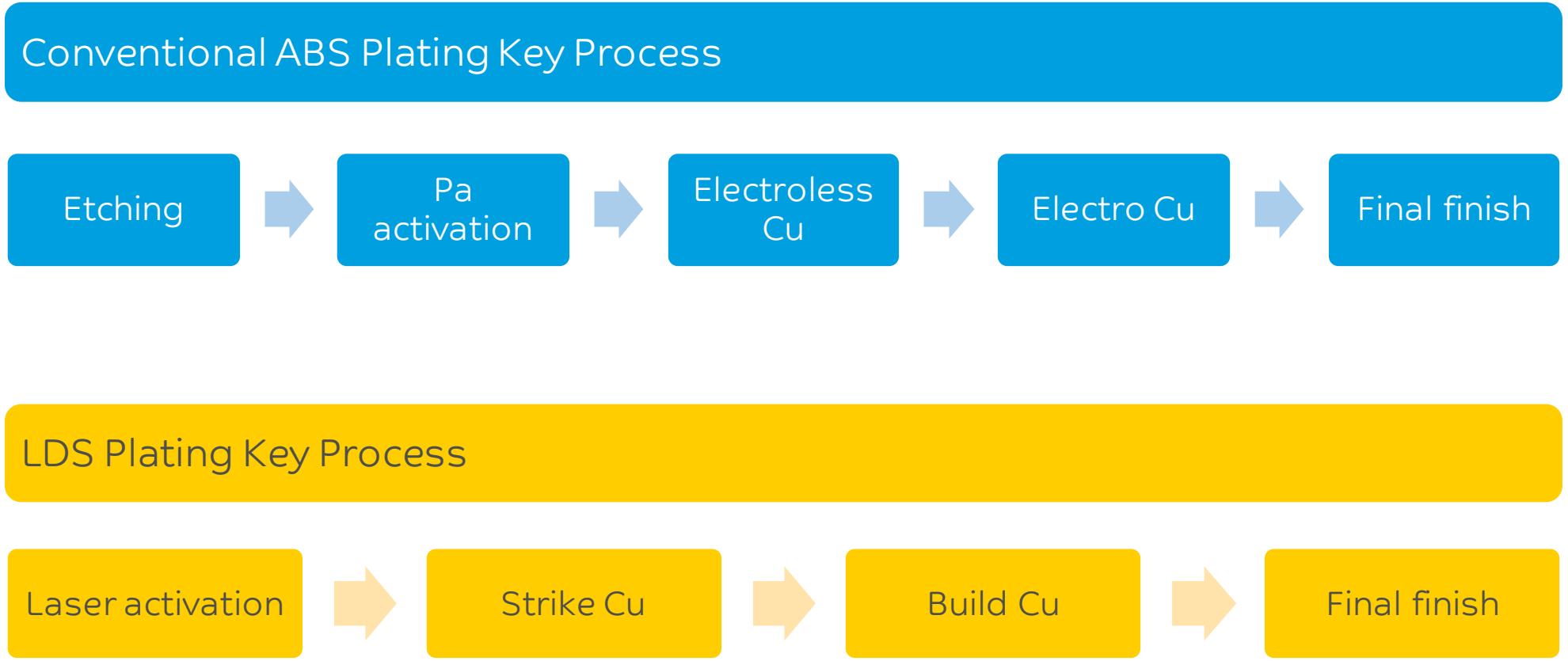
RECOMMENDED LASER OPERATING PARAMETERS

	The recommended laser structure parameters								
	1			2			3		
Grade	Power(W)	Frequency(KHz)	Speed(m/s)	Power(W)	Frequency(KHz)	Speed(m/s)	Power(W)	Frequency(KHz)	Speed(m/s)
NX10302	5	100	4	3	100	4	2	100	2
NX11302	8	40	2	9	100	4	5	100	2
DX11354	9	100	4	7	80	4	5	100	2
DX11355	10	100	2	9	80	4	7	80	4
DX11354X	8	40	2	8	70	2	8	100	2
DF002FV *	8	40	2	8	70	2	8	100	2
DX13354	8	40	2	8	70	2	8	100	2
DX13354X *	8	40	2	8	70	2	8	100	2
DX15354 *	7	80	4	7	100	4	9	100	4
DX15354X *	7	80	4	7	100	4	9	100	4
UX08305	8	80	3	9	100	4	10	100	2
UX08325	8	80	3	9	100	4	10	100	2
UF0067V *	5	100	2	8	100	2	10	100	2
DX14354X	8	40	2	8	70	2	8	100	2

All commercialized LDS grades of LNP™THERMOCOMP™ compounds passed LPKF's plating performance evaluation and were approved. Recommended laser conditions generated on the color chip. Other laser conditions also work well base on the application needs - LPKF plating performance criteria : PI>0.7; Peel strength>0.8N/mm

* Pending LPKF global listing

PLATING PROCESS COMPARISON



MACDERMID MID COPPER 100 XD PLATING SOLUTION

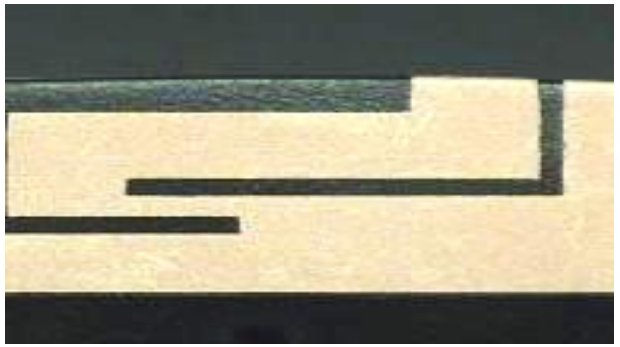
Copper Strike Bath

- Optimized to prevent skip plating
- Provide uniform copper coverage and high adhesion
- High deposition rate required using reaction drivers, NaOH and formaldehyde
- Proprietary additives focus deposition reaction to catalytically active sites on substrate

Copper Build Bath

- Optimized to prevent extraneous plating
- Proprietary additives used to control rate and focus deposition on strike copper
- A controlled deposition rate produces a high quality copper deposit

After copper strike
Strike time:15-30min



After copper build
Rate:>12um/2-4 hrs

Source: from MacDermid MID 100 product introduction

CASE STUDY

CASE STUDY - LNP™ THERMOCOMP™ DX13354 IN SMART WATCH ANTENNA

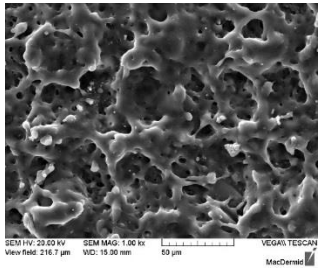
Application: Smartwatch antenna and cover integration part

Application Requirements

- Good balance of modulus and impact
- Good dimension stability, especially after painting
- Good surface

Value Proposition By Using DX13354

- Integration design for various antenna, structure part and circuit
- Lower cost
- Simplify assembly process



No Glass Floating on laser surface

DISCLAIMER

DISCLAIMER: THE MATERIALS, PRODUCTS AND SERVICES OF SAUDI BASIC INDUSTRIES CORPORATION (SABIC) OR ITS SUBSIDIARIES OR AFFILIATES ("SELLER") ARE SOLD SUBJECT TO SELLER'S STANDARD CONDITIONS OF SALE, WHICH ARE AVAILABLE UPON REQUEST. INFORMATION AND RECOMMENDATIONS CONTAINED IN THIS DOCUMENT ARE GIVEN IN GOOD FAITH. HOWEVER, SELLER MAKES NO EXPRESS OR IMPLIED REPRESENTATION, WARRANTY OR GUARANTEE (i) THAT ANY RESULTS DESCRIBED IN THIS DOCUMENT WILL BE OBTAINED UNDER END-USE CONDITIONS, OR (ii) AS TO THE EFFECTIVENESS OR SAFETY OF ANY DESIGN OR APPLICATION INCORPORATING SELLER'S MATERIALS, PRODUCTS, SERVICES OR RECOMMENDATIONS. UNLESS OTHERWISE PROVIDED IN SELLER'S STANDARD CONDITIONS OF SALE, SELLER SHALL NOT BE RESPONSIBLE FOR ANY LOSS RESULTING FROM ANY USE OF ITS MATERIALS, PRODUCTS, SERVICES OR RECOMMENDATIONS DESCRIBED IN THIS DOCUMENT. Each user is responsible for making its own determination as to the suitability of Seller's materials, products, services or recommendations for the user's particular use through appropriate end-use and other testing and analysis. Nothing in any document or oral statement shall be deemed to alter or waive any provision of Seller's Standard Conditions of Sale or this Disclaimer, unless it is specifically agreed to in a writing signed by Seller. Statements by Seller concerning a possible use of any material, product, service or design do not, are not intended to, and should not be construed to grant any license under any patent or other intellectual property right of Seller or as a recommendation for the use of any material, product, service or design in a manner that infringes any patent or other intellectual property right.

Any brands, products or services of other companies referenced in this document are the trademarks, service marks and/or trade names of their respective holders.


THANK YOU