Multilayered thin type lightweight coil for wireless power transmission for EV and leakage magnetic field suppression effect

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Outline

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    2.Motivation of this research

2.Results and discussion
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    5.Control of Joule's heat

3.Conclusions

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1.Introduction

Issues of conventional WPT coil units

We think that the present WPT coil units for EV/PHEV have the following issues.

1. The leakage magnetic field could cause harmful influence on surrounding electronic devices and living objects when transmitting high power.

2. Thick, heavy, using lots of copper material for manufacturing.

3. Mass production issues

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1.Introduction

Motivation

We propose a coil unit design with the following features based on precise metal Layer pattering process by photolithography technology.

1. Suppression of Leakage magnetic field

2. Thin, light weight, and using smaller amount of copper material.

3. Suitable for mass production

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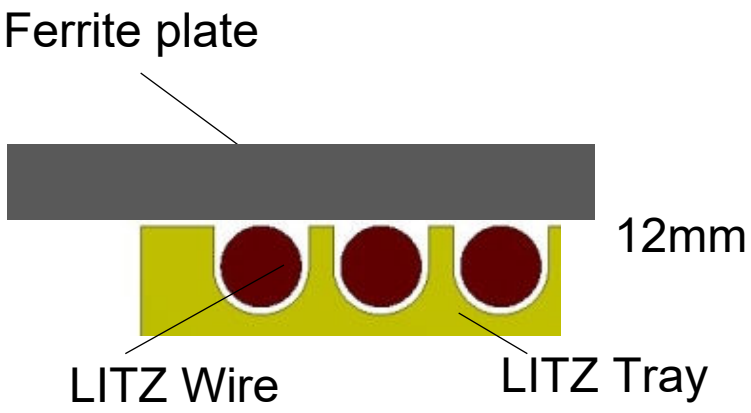
2.Results and discussion

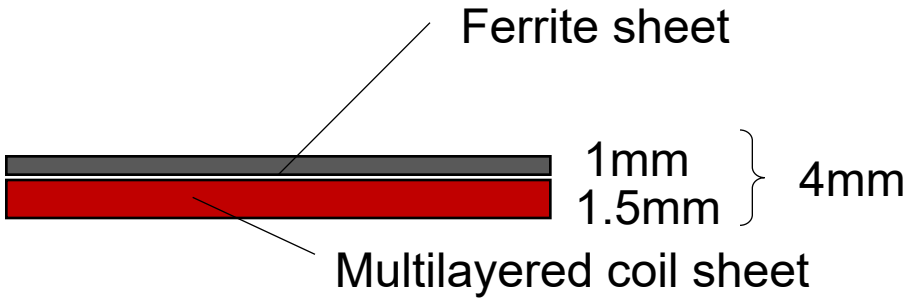
Comparison between conventional coil unit and multi-layered coil

Conventional Coil unit



LITZ wire : 1.3kg
Ferrite : 2.7kg
} 4.0kg

Multilayered coil sheet



Multilayered coil sheet : 0.46kg
Ferrite sheet : 0.49kg
} 0.95kg

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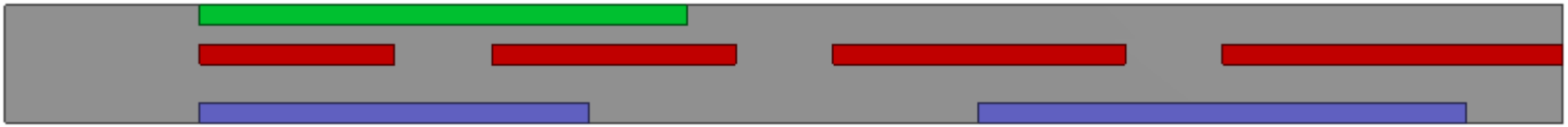
2.Results and discussion

Configuration of the multilayered thin type lightweight coil



- Thickness of Cupper layer are 0.2mm
- Gap between coils are 0.2~0.4mm
- Part of an example cross section

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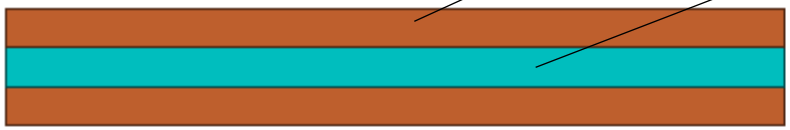
2.Results and discussion

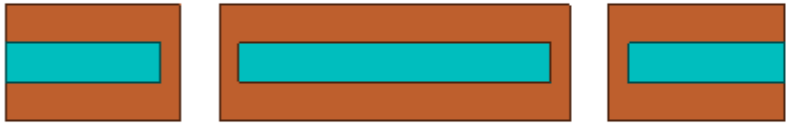
Process

Standard PCB manufacturing technology can be applied

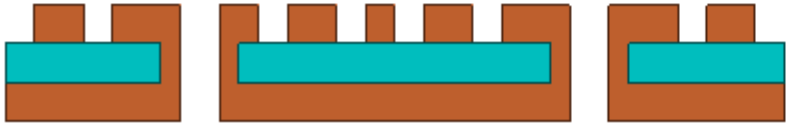
1)Base material



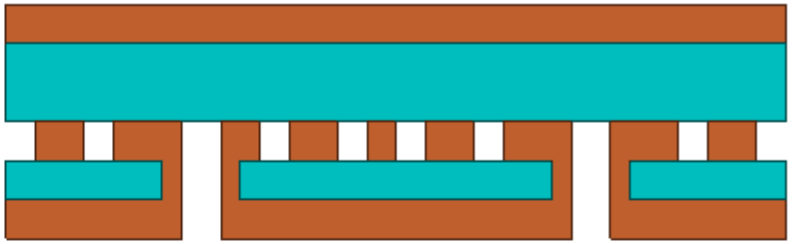
2)Connecting by through hole



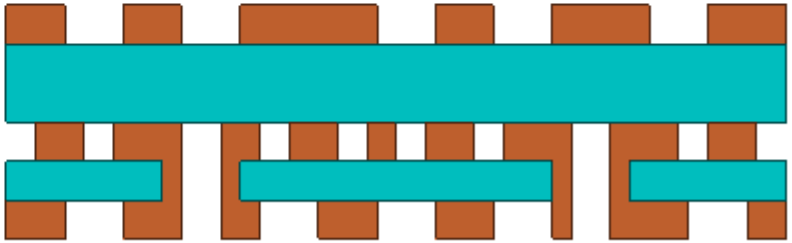
3)Pattern one side by photolithography



4)Laminate another layer

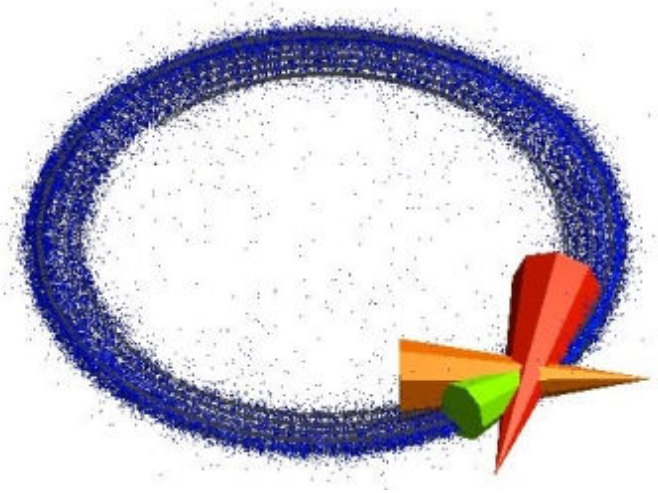


5)Pattern both sides by photolithography

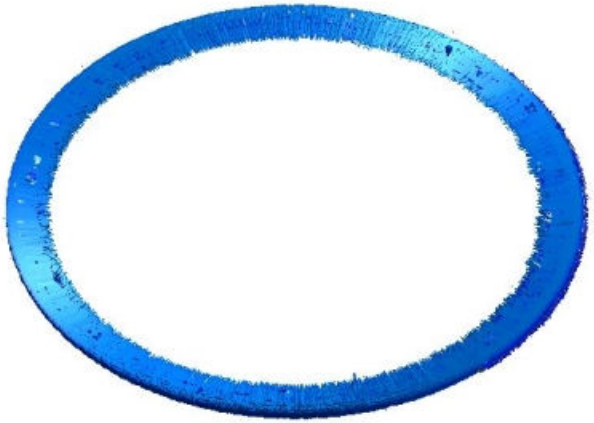


2.Results and discussion

Suppression of leakage magnetic field emitted from WPT coil



Conventional coil
(Single layer coil)



Our idea
(Multilayered coil)

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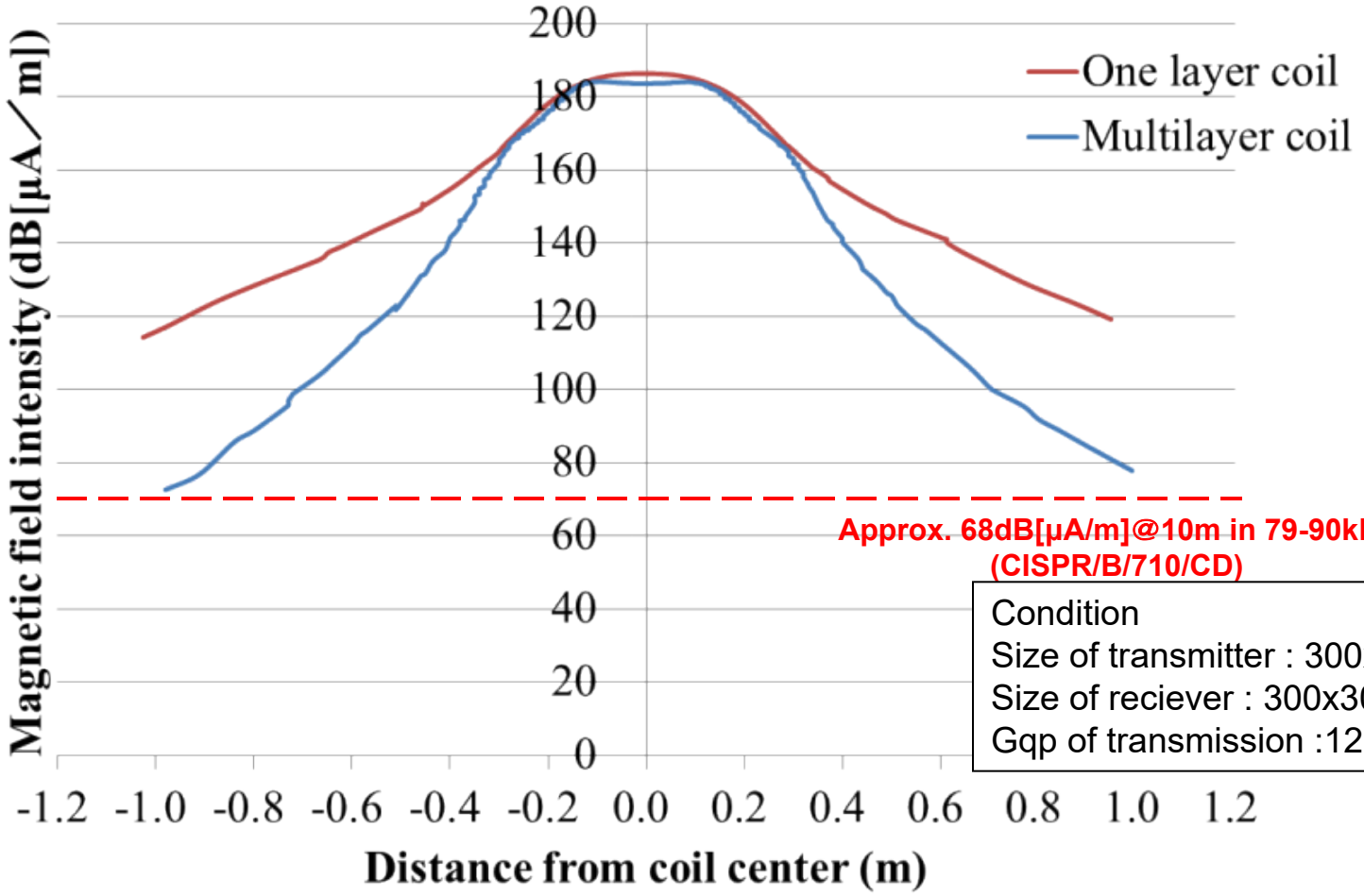
2.Results and discussion



Comparison of leakage magnetic field intensity between single layer and multilayer coil.

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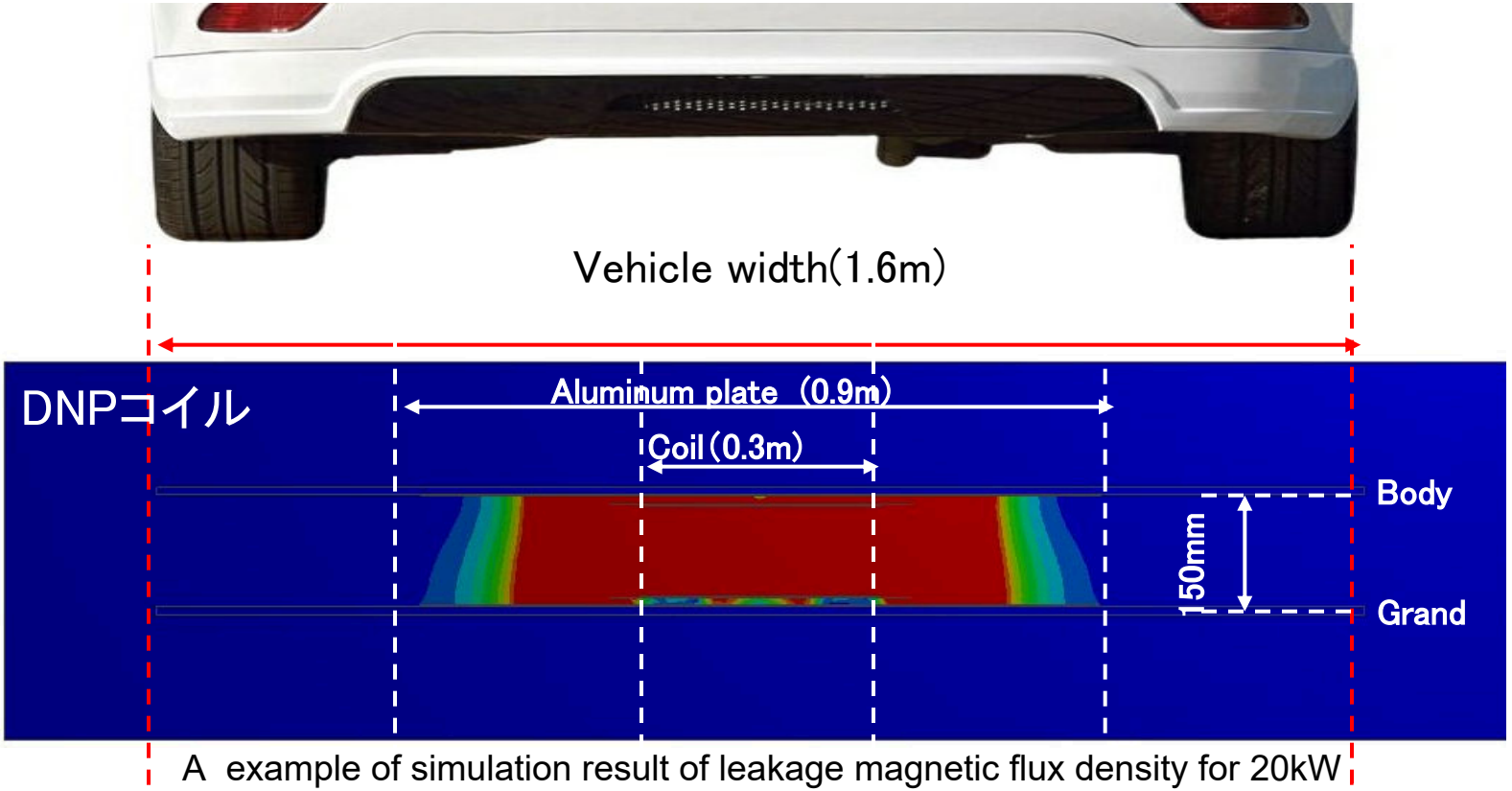
2.Results and discussion

Simulation result of leaked magnetic flux density



A example of simulation result of leakage magnetic flux density for 20kW transmission condition. The dimensions refer to SAE (J2954)
The vehicle body assumed Carbon Fiber Reinforced Plastics (CFRP.)
Proposed multilayered coil design can reduce the area of the aluminum plate

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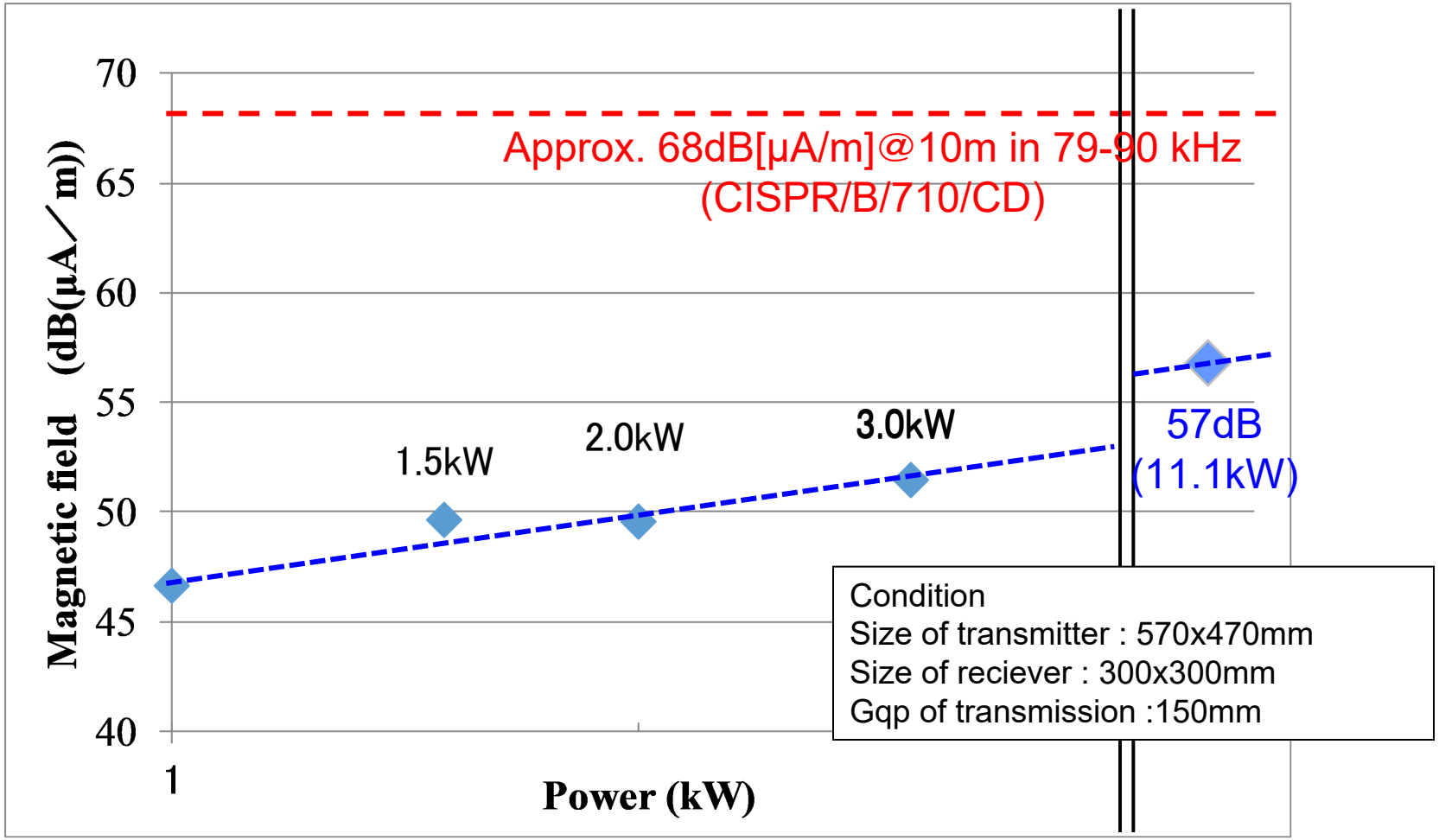
2.Results and discussion

Measured magnetic field strength



The magnetic field for 11.1 W transmission is expected to be about 57 dB(μA/m)@10m.

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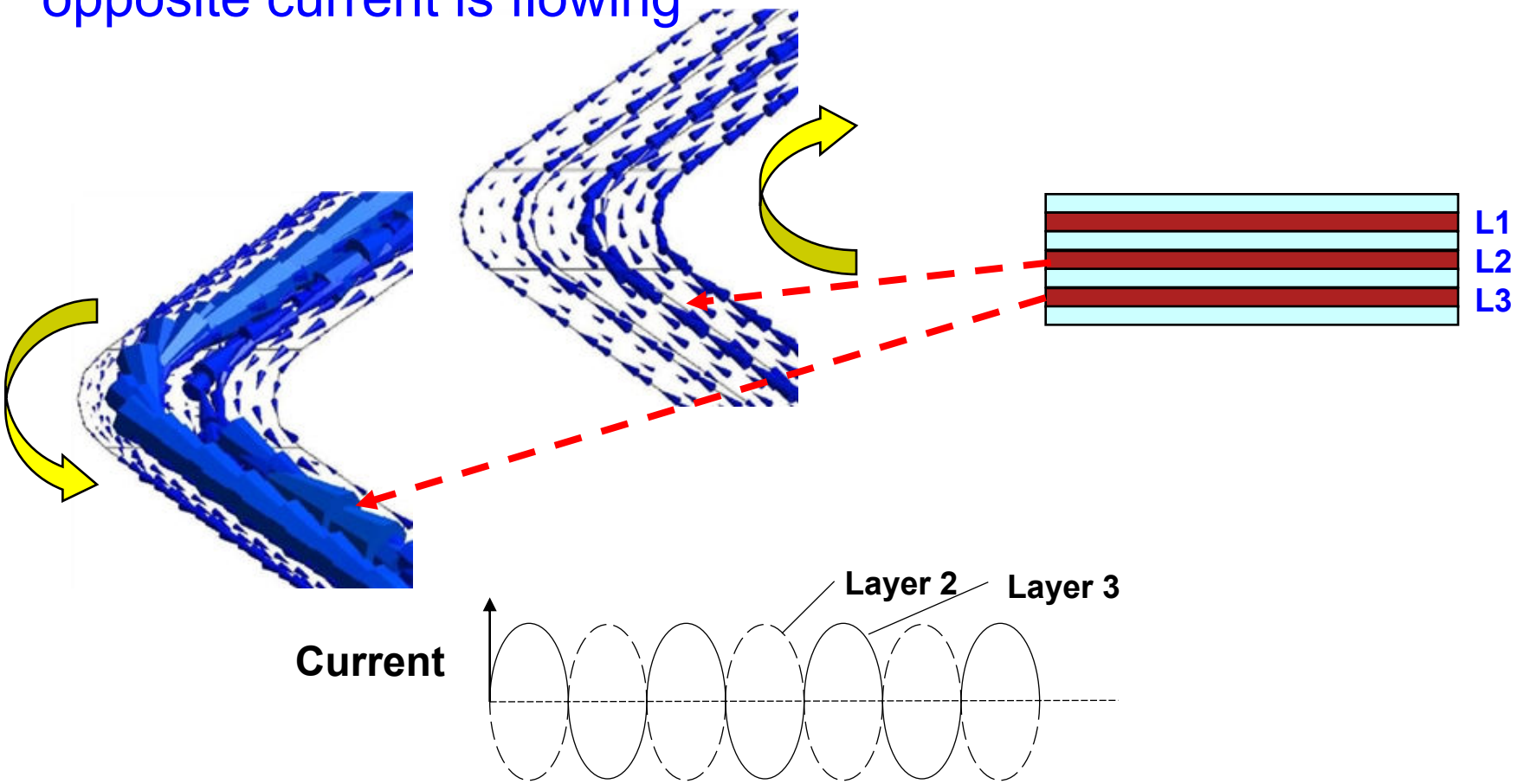
Leakage magnetic field suppression

Unnecessary leakage magnetic field is suppressed by canceling of magnetic field from two layers in which opposite current is flowing



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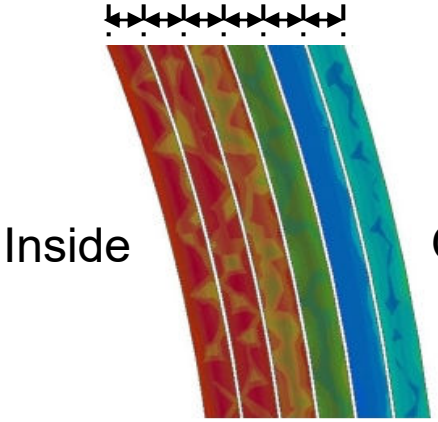
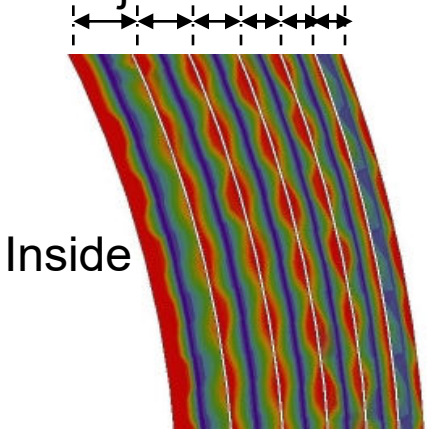
2.Results and discussion

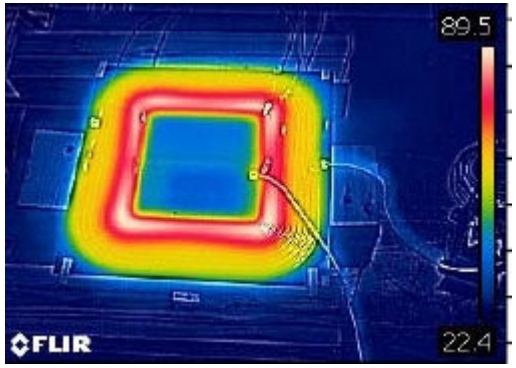
Improvement thermal characterization copper pattern design

Uniform width



Adjusted width

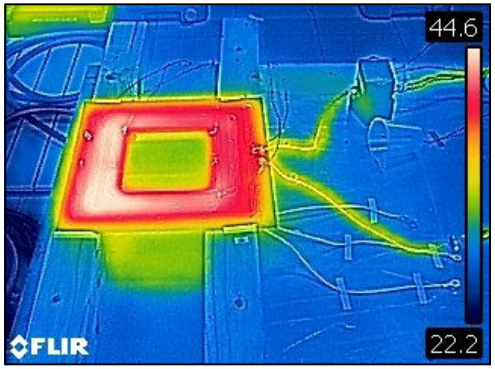




89.5℃

22.4℃

All copper widths are uniform. The inside of the coil becomes particularly hot. (About 90℃)



44.6℃

22.2℃

Copper width was adjusted so as to average current density. (Max. Temp is 44℃)

A thermographic image when a current of 20 A was flowed

3.Conclutions

(1)A kilo-watt order WPT for EV/PHEV can be realized with thin, light weight multilayered coil unit. Then leakage magnetic field is suppressed effectively.

(2)Layered power line optimization demonstrated efficient current flow and Joule heat reduction.

(3) Proposed design is suitable for mass production and facilitates manufacturing

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thank you for your attention

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