

April 16, 2019  
Hitachi Metals, Ltd.

Fraunhofer Institute for Integrated Systems and Device Technology IISB

## Fraunhofer IISB and Hitachi Metals Develop New Technology to Enhance the Power Density in Compact On-Board Chargers

Fraunhofer Institute for Integrated Systems and Device Technology IISB (hereinafter, "Fraunhofer IISB") and the Global Research & Innovative Technology Center (hereinafter, "GRIT") of Hitachi Metals, Ltd. (hereinafter, "Hitachi Metals") have jointly developed a technology to enhance the power density in the compact on-board charger (OBC) used in electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). It has been confirmed that the technology enables the OBC prototype we have created to generate the world's highest\*<sup>1</sup> power density of 3.8 kW/L.

### 1. Background

An OBC converts alternating-current voltage to direct-current voltage (i.e., it is an AC/DC converter) to supply power to EV and PHEV batteries. The OBC is required to provide high power output to charge the EV and PHEV batteries in a short period of time, and at the same time it has to be sufficiently compact to keep the space inside the vehicle as large as possible. However, there is a trade-off between high output and compactness of the body, and therefore achieving a good balance between the two has been a challenge.

Against this backdrop, Fraunhofer IISB and Hitachi Metals produced an OBC prototype that delivers both high power output and compactness utilizing our exclusive high power density enhancement technology.

### 2. Overview

The OBC prototype we have created delivers both high power output and a compact body by combining soft magnetic materials and components developed by Hitachi Metals and Fraunhofer IISB's circuit technology. In concrete terms, we have adopted a nanocrystalline alloy called FINEMET® FT-3K50T for the common-mode choke coils in the input/output noise filter, and another choke coil made with an amorphous powder core HLM50 for rectification and power factor correction. Furthermore, the isolation transformer with resonance inductors made of the low-loss soft ferrite core ML29D is used in the DC/DC converter. In addition to achieving the world's highest power density of 3.8 kW/L, we have also confirmed 11 kW output and three phase input operation by using parallel connected 3 OBCs. This parallel connection can cover both single- and three-phase AC input to produce a maximum output of 22 kW through six parallel connections.

This flexibility can significantly reduce the OBC design time and costs.



OBC prototypes  
Single-phase kilowatts: 3.6 (left)  
Three-phase kilowatts: 11 (right)

On this joint development achievement, Mr. Kenichi Inoue, the General Manager, GRIT stated: "We are extremely pleased that we could achieve the positive prospect of delivering both high power output and casing compactness for the OBC, which has been a significant challenge over the years. This prototype is a demonstration of the superiority of the characteristic soft magnetic materials and components that Hitachi Metals can produce. We would like to promote new applications of our soft magnetic materials and components toward the further development of xEVs."<sup>2</sup>

Also, Dr. Bernd Eckardt, Head of Automotive Electronics, Fraunhofer IISB commented as follows: "By using the advanced magnetic materials of GRIT we were able to realize an ultra-compact and modular OBC with high efficiency. The highly integrated mechatronic design allows an easy scale up in power from 3.6 kW up to 22 kW."

The OBC prototype will be displayed in the Fraunhofer IISB booth and Hitachi Metals at the following exhibitions: PCIM Europe held on May 7, Tue to 9, Thu, 2019 at Exhibition Centre Nuremburg in Germany (Booth number of Fraunhofer IISB: 6.438, Hitachi Metals: 7.306 ).

[Supplementary Information]

■ Specifications of the OBC prototype

Dimensions	200 x 100 x 40 mm / unit
Switching frequency	AC/DC: 110–130 kHz DC/DC: 250–300 kHz
Voltage	Input: 230 V (AC) Output: 350–450 V (DC)
Maximum output	3.6 kW (a single unit with single phase input) 22 kW (six units in parallel connection with single/three-phase input)

- \*1 This is the world's highest power density for an in-vehicle charger as of April 16, 2019. Researched by Hitachi Metals.
- \*2 Refers to electric vehicles, hybrid electric vehicles, and plug-in hybrid electric vehicles

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**About Fraunhofer IISB**

As an Institute of the Fraunhofer Research Society with Headquarter in Munich, Germany, the Fraunhofer IISB, located in 91058 Erlangen, Germany, is covering the field of power electronic from material science, semiconductor and interconnection technologies up to automotive and energy power electronics. For more information, visit [www.iisb.fraunhofer.de](http://www.iisb.fraunhofer.de)

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**About Hitachi Metals, Ltd.**

Hitachi Metals, Ltd., (TSE: 5486), headquartered in Tokyo, Japan, with consolidated revenue totaling 988 billion yen in fiscal 2017(ended March 31, 2018). The company manufactures and markets a diverse portfolio of advanced metals products, and advanced components and materials. For more information, visit [www.hitachi-metals.co.jp/e/](http://www.hitachi-metals.co.jp/e/)