

# Preventing Electrical Corrosion of Bearings in Electrified Drivetrains

MOTION & CONTROL™  
**NSK**

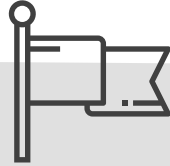
Location: The Bearing Show 2022, Essen, Germany  
Presenter: Dr. Jens Dörner, European R&D Director  
E-Mail: [doerner-j@nsk.com](mailto:doerner-j@nsk.com)  
Date: 07.09.2022

# 1. Introduction to NSK - Global Company Profile

NSK Ltd., Japan (Nippon Seiko K.K.)

**1916**

Established in Japan



**Group Companies**

19 in Japan, 72 outside Japan



**~30,577\***

Employees global

\* excl. temp. employees, Note: per March 2022



Sales of  
**~ € 6,3 bn**

|     |               |
|-----|---------------|
| 56% | Automotive    |
| 40% | Industrial    |
| 4%  | Other Markets |

Japan No.1  
Global No.3

## Bearings



## Electric Power Steering Systems

Global No.2

## Ball Screws

Global No.1



Source: NSK Annual Report

# 1. Introduction to NSK - European Technology Centres

## Application Engineering

- Technical support for customers, distributors & manufacturing operations

## Design

- New product design & development

## Technology Scouting Office

- Identification, Evaluation and Implementation of new technologies through Open Innovation
- Competitive Intelligence through Market Research

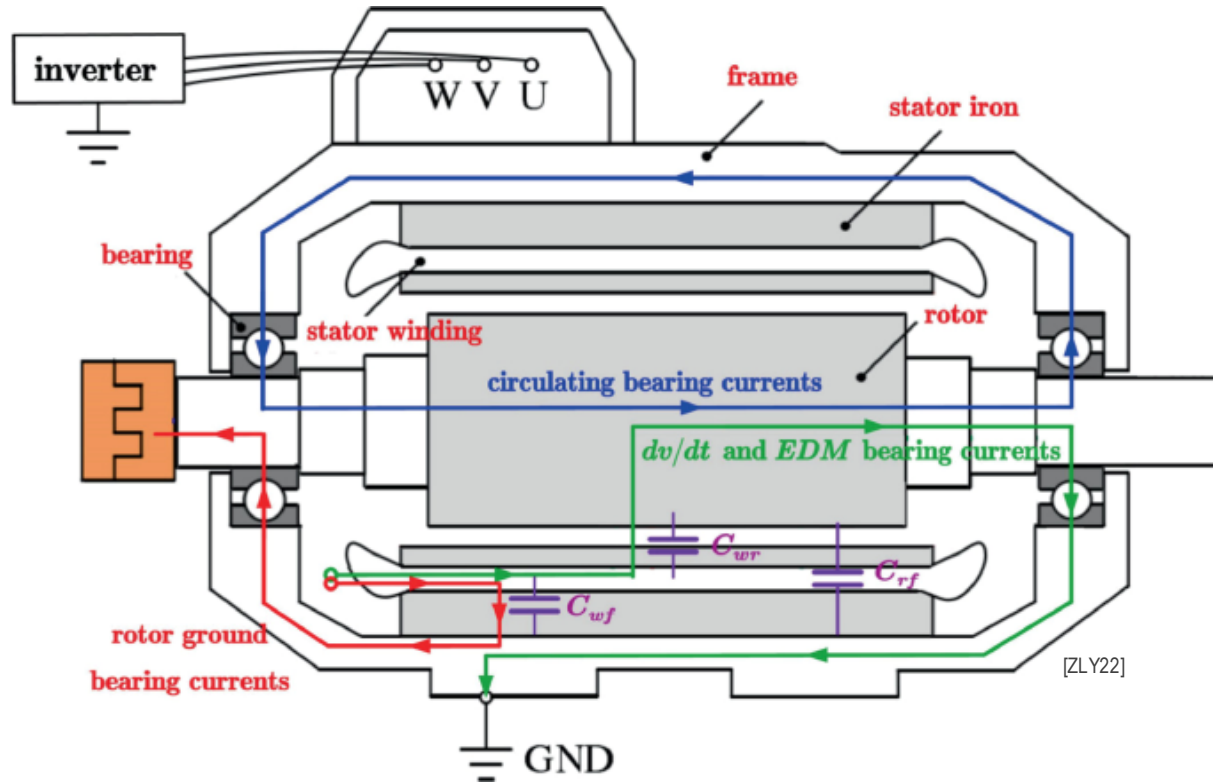
## Investigation

- Detailed analysis of bearings & surrounding components

## Testing

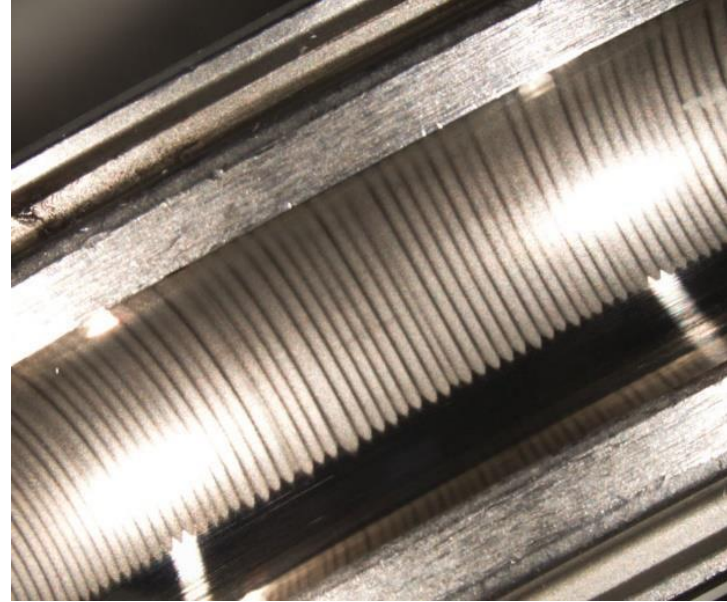
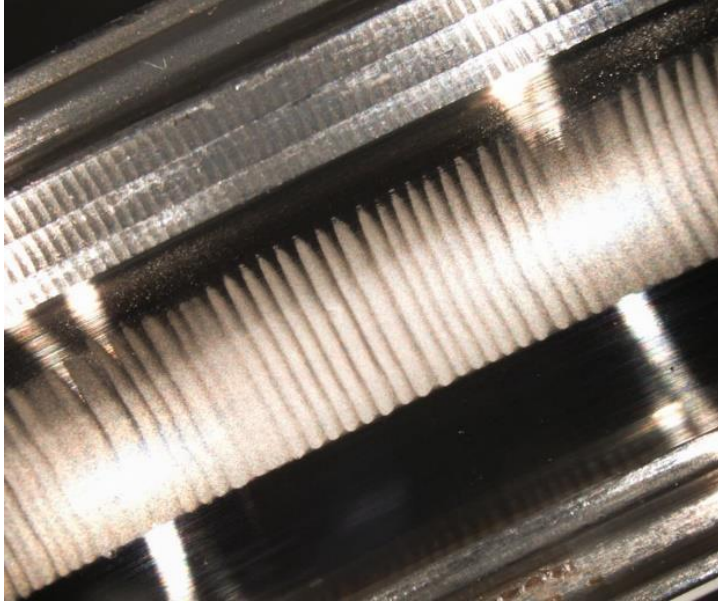
- Application-related testing

## 2. Motivation and Background - Bearing Current Mechanisms

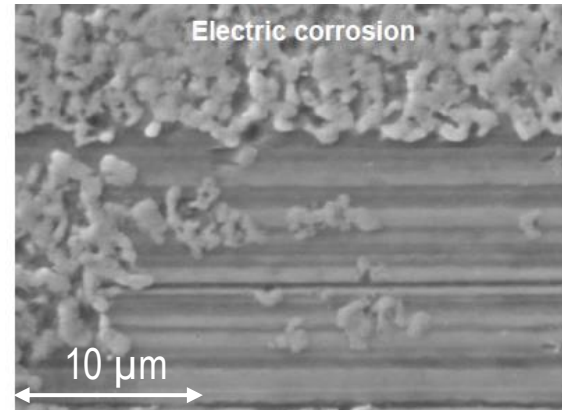
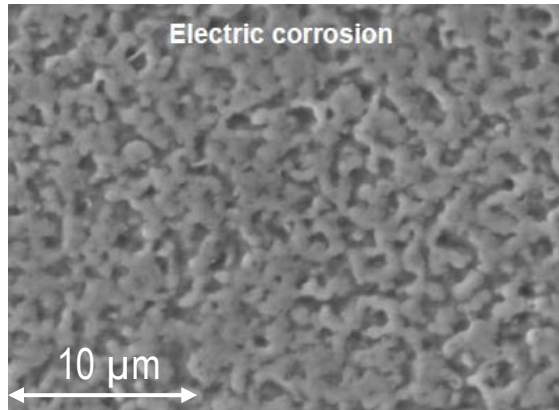
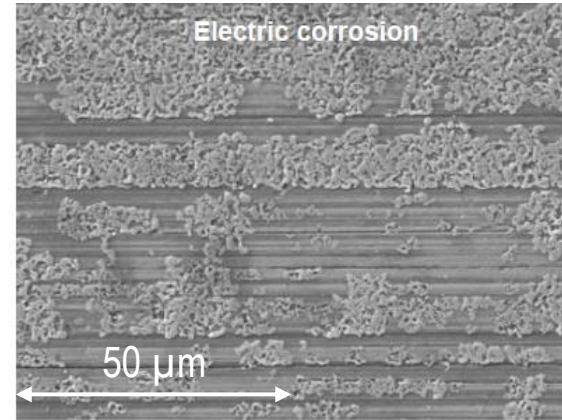
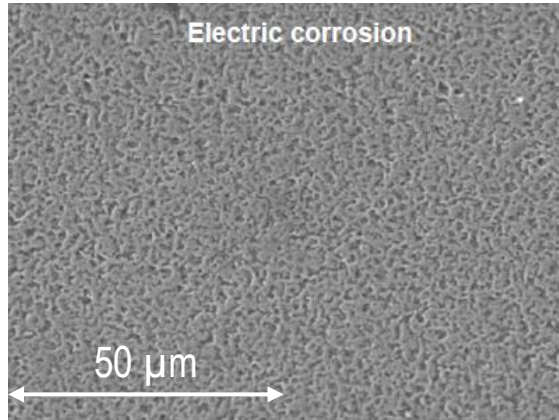


\*electric discharge machining

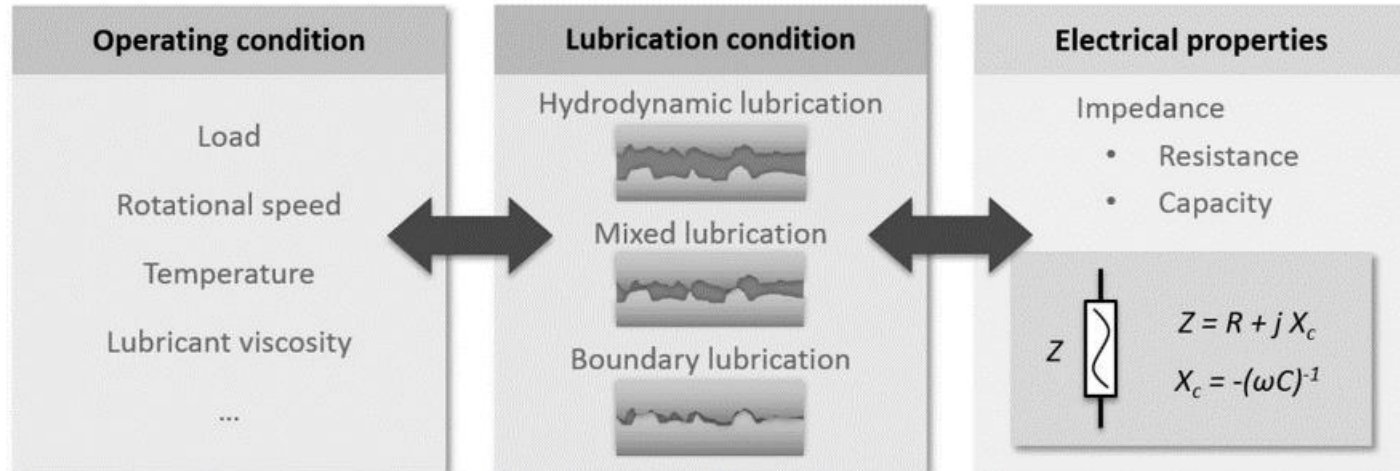
## 2. Motivation and Background - Failure Modes



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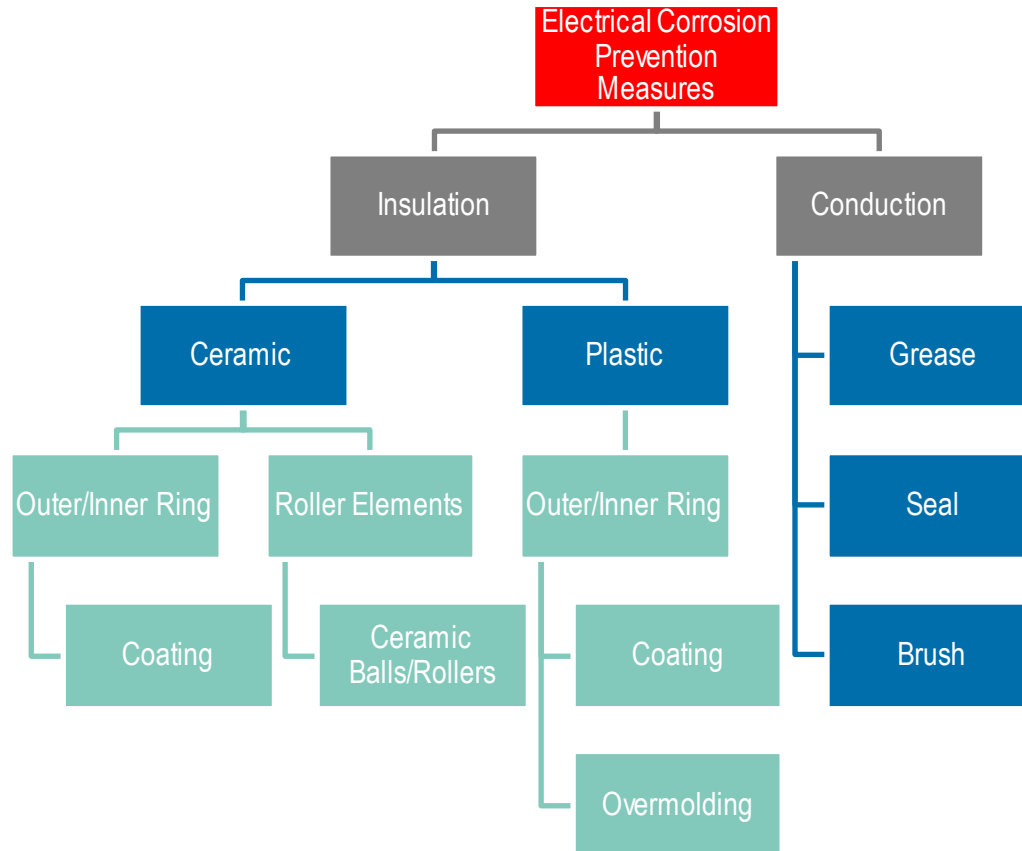


## 2. Motivation and Background

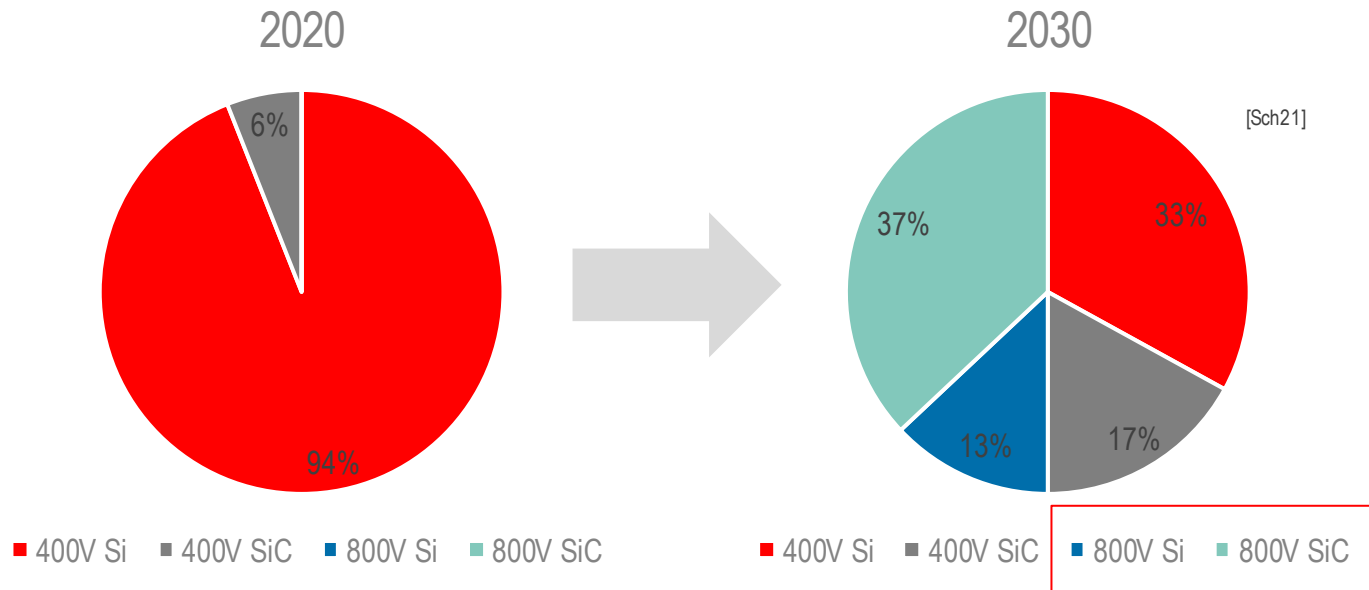


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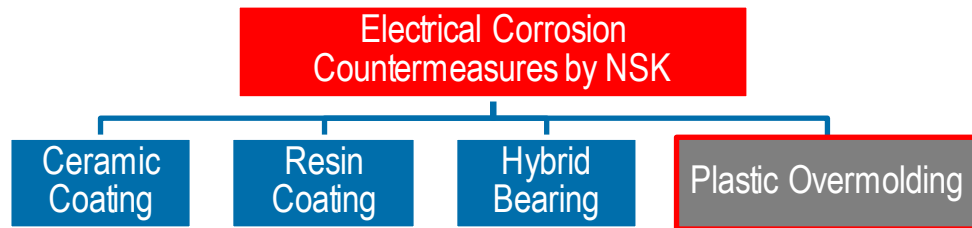
## 2. Motivation and Background - El. Corrosion Prevention Measures



## 2. Motivation and Background - e-Axle Market Forecast



### 3. Development at NSK



#### **MATERIAL:**

- High-Performance Polymer enabling high resistance against heat, large variety of chemicals and stable electrical and mechanical performance even at operating temperatures up to 150°C
- Low level of water absorption resulting in a stable mechanical performance as well as stable dimensions

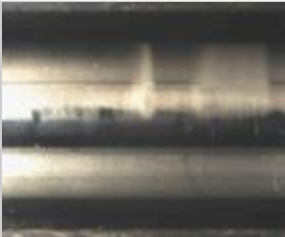
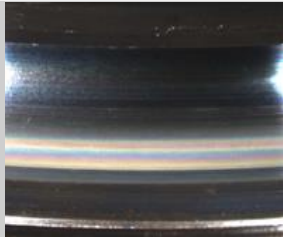
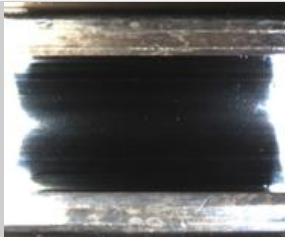
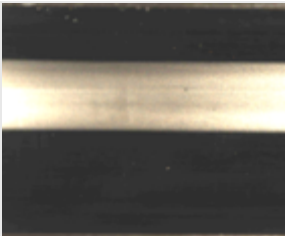
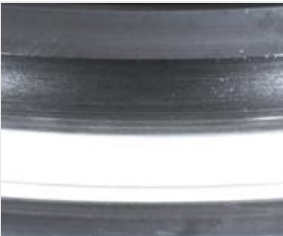
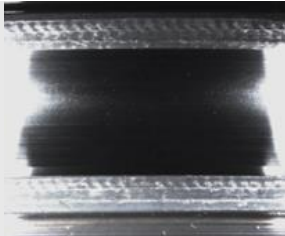
#### **PROCESS:**

- Innovative injection molding process enabling best mechanical and electrical performance enabling typical bearing tolerance levels
- Highly productive and fully produced in Europe to keep supply chains for European customers short and CO<sub>2</sub> emissions caused by logistics low

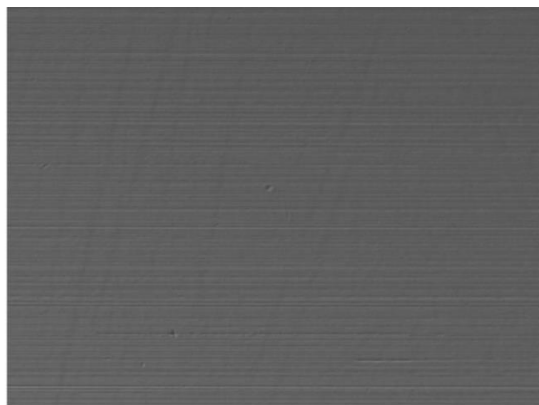
#### **DESIGN:**

- New product design supporting an optimal electrical insulation performance
- Depending on bearing type and expected loads, outer diameter can be kept for ease of our customers (space neutral)
- Insulation applicable on inner and outer ring. Insulation layer thickness ranges from 0.7 mm – 1.2 mm

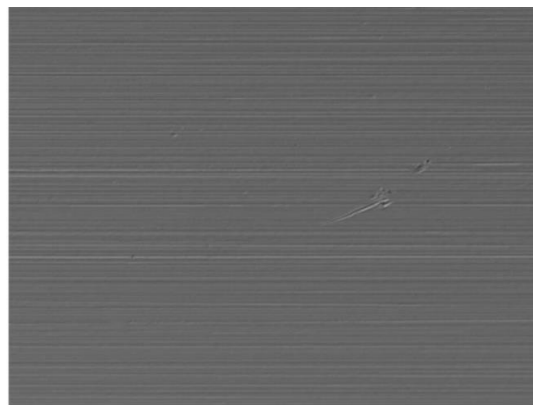
### 3. Development at NSK

|                                                                                                           | Standard Bearing                                                                                |                                                                                                  | NSK Overmolded Bearing                                                                            |                                                                                                   |
|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| <b>Test Condition 1:</b><br>Radial Load: 1kN<br>Speed: 3000rpm<br>Voltage: 24V (p-p)<br>Frequency: 15kHz  | <br>Outer ring | <br>Inner ring | <br>Outer ring | <br>Inner ring |
|                                                                                                           | Clear electrical corrosion                                                                      |                                                                                                  | No evidence for electrical corrosion                                                              |                                                                                                   |
| <b>Test Condition 2:</b><br>Radial Load: 1kN<br>Speed: 10000rpm<br>Voltage: 24V (p-p)<br>Frequency: 15kHz | <br>Outer ring | <br>Inner ring | <br>Outer ring | <br>Inner ring |
|                                                                                                           | Clear electrical corrosion                                                                      |                                                                                                  | No evidence for electrical corrosion                                                              |                                                                                                   |

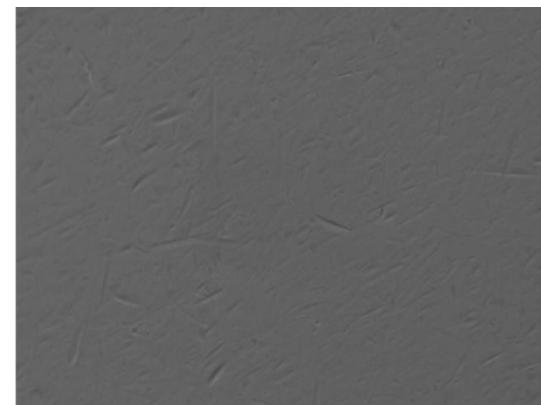
### 3. Development at NSK



100µm  
Inner ring  
center of raceway running band



100µm  
Outer ring  
center of raceway running band



25µm  
Ball  
center of raceway running band

#### DEVELOPMENT STATUS

- DONE
  - Patent
  - Modular mold: OD: 55-95 mm, max, width: 30 mm
  - Lifetime and Electro Corrosion tests
- ONGOING
  - Heat Cycle / Aging tests
  - Chemical resistance tests

Samples  
available

#### BENEFITS AND FEATURES:

- Aiming to prevent electrical corrosion caused by EDM\* which occurs in electrified drivetrains
- Technology covers large variety of DGBB dimensions and available for sealed and non-sealed bearings
- Space neutral design possible
- Cost saving comparing hybrid bearings

\*electric discharge machining

## 4. Sources

| [GCB19] | Gonda, A., Capan, R., Bechev, D., & Sauer, B. (2019). The influence of lubricant conductivity on bearing currents in the case of rolling bearing greases. Lubricants, 7(12), 108.                                                                              |
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| [Sch21] | Scharrer, O. (2021). E-mobility accelerated – Trends and dynamics of the drivetrain transformation, CTI Symposium, Berlin 2021                                                                                                                                 |
| [ZLY22] | Zhi, Y., Li, Y., Yan, G. et al. (2022). Review of Motor Bearing Currents in Inverter Drive System. In: The proceedings of the 16th Annual Conference of China Electrotechnical Society. Lecture Notes in Electrical Engineering, vol 891. Springer, Singapore. |