



**ESSIAL**

**Deliverable D3.5**  
**Insulating material specifications**

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2	6/4/2018	D Martínez-Avial	Assessment of data
3	23/4/2018	D Laloy	Data about coatings

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## **Summary**

This deliverable aims at summarizing the insulation requirements of commercial insulating layers according to prototypes defined in WP5. Currently, these components are made of 23MOH (GO FeSi steel) and M400-65A (NO FeSi steel). Three prototypes will be manufactured as part of the ESSIAL project:

- Prototype 1A and 1B: power inductors (inverter and LVPS inductors).
- Prototype 2: transformer.
- Prototype 3: rotating electrical machines.

## **Prototypes 1A and 1B**

Manufacturer of the prototype: SEPSA

Steel: 23MOH

Commercial insulator name: Carlite / Punching Quality Carlite

Type of coating (ASTM code and chemical characteristics): C5 over C2. Inorganic layer (phosphate coating) applied on magnesium silicate layer.

SEPSA requires Carlite insulation coating. However, they do not have specifications for its properties. The following properties are typical from this coating, measured from commercial samples and/or according to literature.

Insulation resistance <sup>a</sup>:  $\geq 10 \Omega \cdot \text{cm}^2/\text{side}$  <sup>b</sup>

Adherence by bending test <sup>c</sup>: No detachment

Temperature resistance: 180 °C

Thickness: 2-6  $\mu\text{m}$

Encapsulating resins: two encapsulating resins are used for Sepsa. As a first step, Epoxylite 578EB is applied on the whole. Elmotherm 6001 is used as finishing resin.

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<sup>a</sup> Evaluated by Franklin test (EN 60404-11:2013 / ASTM A717)

<sup>b</sup> [http://www.waasner.de/fileadmin/Assets/PDFs/MagTechnProperties\\_112011.pdf](http://www.waasner.de/fileadmin/Assets/PDFs/MagTechnProperties_112011.pdf) (March 2018)

<sup>c</sup> The insulation adherence is evaluated from bending test at 90° on a 10 mm diameter rod. Scotch tape (Cellophane 610, 3M) is applied on the bended area, checking if there is no detachment when it is removed (by visual inspection)

1) Epoxylite 578EB: epoxy resin system

Thermal Class: 180 °C

Shore D Hardness: 90 (at 25 °C)

Tg: 125 °C

Water absorption: 0.18% (at 23 °C)

Application mode: Vacuum Pressure Impregnation process

2) Elmotherm 6001: epoxy varnish

Thermal Class: 180 °C

Shore D Hardness: 80 (at 25 °C)

Tg: > 90 °C

Water absorption: <0.1% (at 23 °C)

Application mode: dip or spray

## **Prototype 2**

Manufacturer of the prototype: SEPSA

Steel: 23MOH

Commercial insulator name: Carlite / Punching Quality Carlite

Type of coating (ASTM code and chemical characteristics): C5 over C2. Inorganic layer (phosphate coating) applied on magnesium silicate layer.

SEPSA requires Carlite insulation coating. However, they do not have specifications for its properties. The following properties are typical from this coating, measured from commercial samples and/or according to literature.

Insulation resistance <sup>a</sup>:  $\geq 10 \Omega \cdot \text{cm}^2/\text{side}$  <sup>b</sup>

Adherence by bending test <sup>c</sup>: No detachment

Temperature resistance: 180 °C

Thickness: 2-6  $\mu\text{m}$

Encapsulating resins: two encapsulating resin are used for Sepsa. As a first step, Epoxylite 578EB is applied on the whole. Elmotherm 6001 is used as finishing resin.

1) Epoxylite 578EB: epoxy resin system

Thermal Class: 180 °C

Shore D Hardness: 90 (at 25 °C)

Tg: 125 °C

Water absorption: 0.18% (at 23 °C)

Application mode : Vacuum Pressure Impregnation process

2) Elmotherm 6001: epoxy varnish

Thermal Class: 180 °C

Shore D Hardness: 80 (at 25 °C)

Tg: > 90 °C

Water absorption: <0.1% (at 23 °C)

Application mode: dip or spray

## **Prototype 3**

Manufacturer of the prototype: Jeumont

Steel: M400-65A

Commercial insulator name: S46 <sup>d</sup>

Type of coating (ASTM class and chemical characteristics): C3

Insulation resistance <sup>a</sup>: > 10 Ω·cm<sup>2</sup>/side

Adherence by bending test <sup>c</sup>: No detachment

Temperature resistance: 180 °C (continuous) / 600 °C (intermittent)

Thickness: 4-6 μm

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<sup>d</sup> Arcelor-Mittal denomination (other denomination if supplier is different)

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Impregnation resins: Whole component, with epoxy resin following GVPI process.  
Compatibility needed between insulating coating and epoxy resin.

Another two possibilities of insulating coatings can be manufactured at Jeumont for its electrical machines (as those to be manufactured in WP5). In future steps, ESSIAL consortium will decide which of them is the best option for this prototype. The requirements for those coatings are:

→Option 2

Commercial insulator name: ALKOPHOS (Jeumont system)

Type of coating (ASTM class and chemical characteristics): C5

Insulation resistance <sup>a</sup>: > 10 Ω·cm<sup>2</sup>/side

Adherence by bending test <sup>c</sup>: No detachment

Thickness: 1-3 μm

Impregnation resins: Whole component, with epoxy resin following GVPI process.  
Compatibility needed between insulating coating and epoxy resin.

→ Option 3

Commercial insulator name: M6D <sup>d</sup>

Type of coating (ASTM class and chemical characteristics): C6

Insulation resistance <sup>a</sup>: > 50 Ω·cm<sup>2</sup>/side

Adherence by bending test <sup>c</sup>: No detachment

Temperature resistance: 200 °C (continuous) / 700 °C (intermittent)

Thickness: 6-10 μm

Impregnation resins: Whole component, with epoxy resin following GVPI process.  
Compatibility needed between insulating coating and epoxy resin.