23rd International Enamel Congress

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Electrostatic Enamel Powder - the new generation, properties and results

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INTERNATIONAL ENAMELLERS CONGRESS FLORENCE

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Electrostatic enamel powder - the new generation, properties and results

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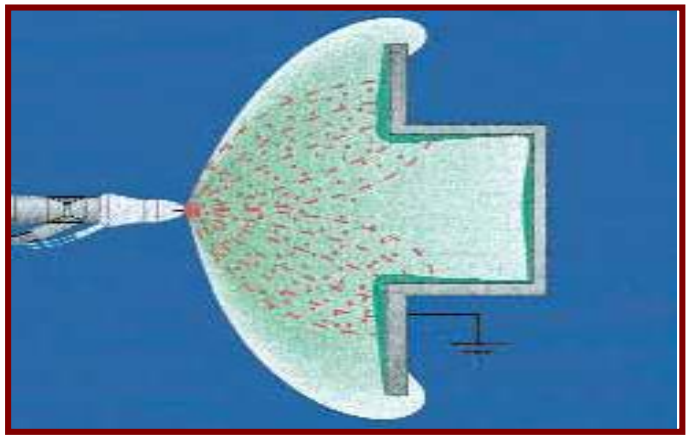
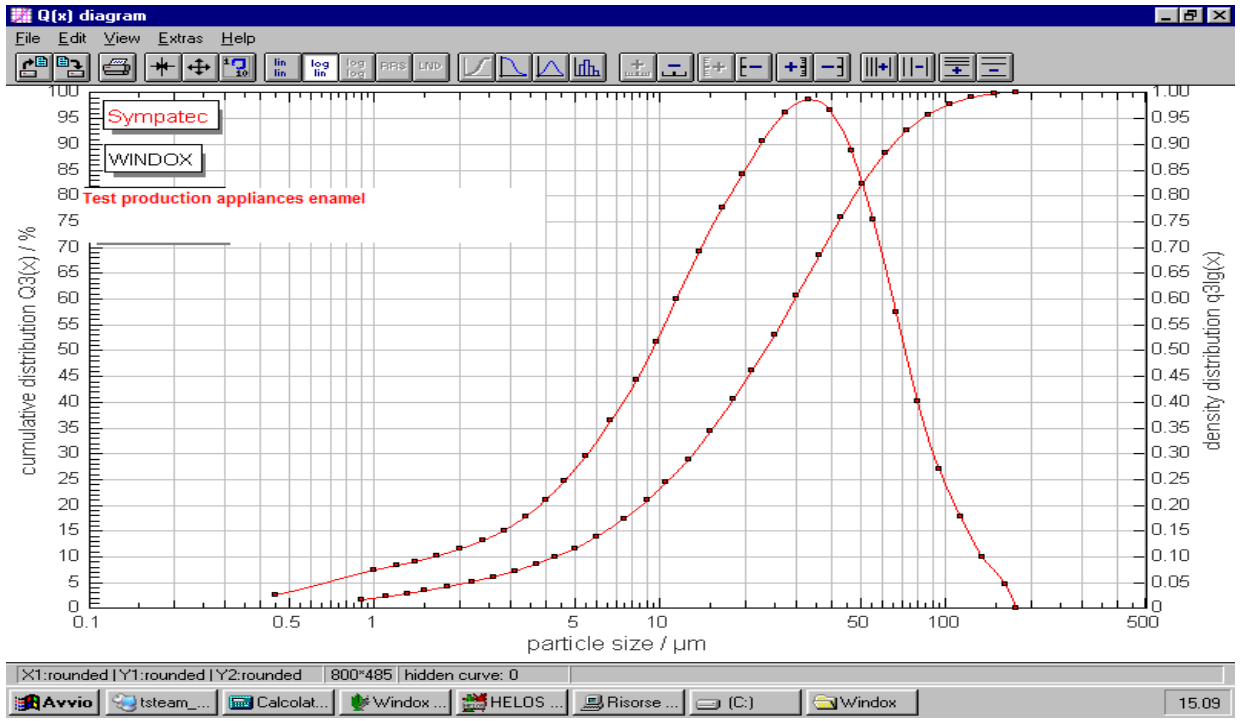
Porcelain Enamel: protective coating for metals in several applications

Pieces design should respect some **rules** and **shapes.**





Enamel should ensure the **best covering properties.**

Distribution on the surface strongly depends on **particle size.**

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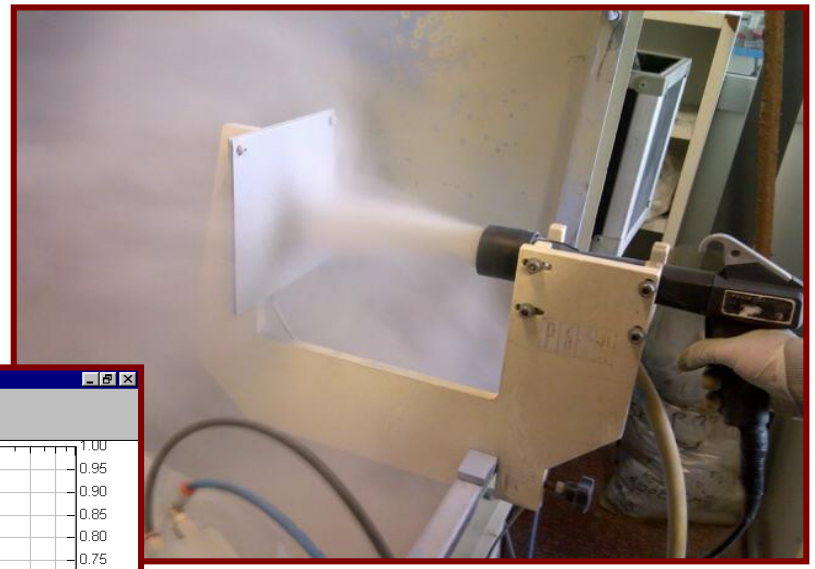
Target:

- Increase **Deposition Rate** (DR)
- Improve enamel **penetration** in corners (Faraday cages)
- Improve coating **thickness homogeneity**
- Reduce enamel **consumption per unit**

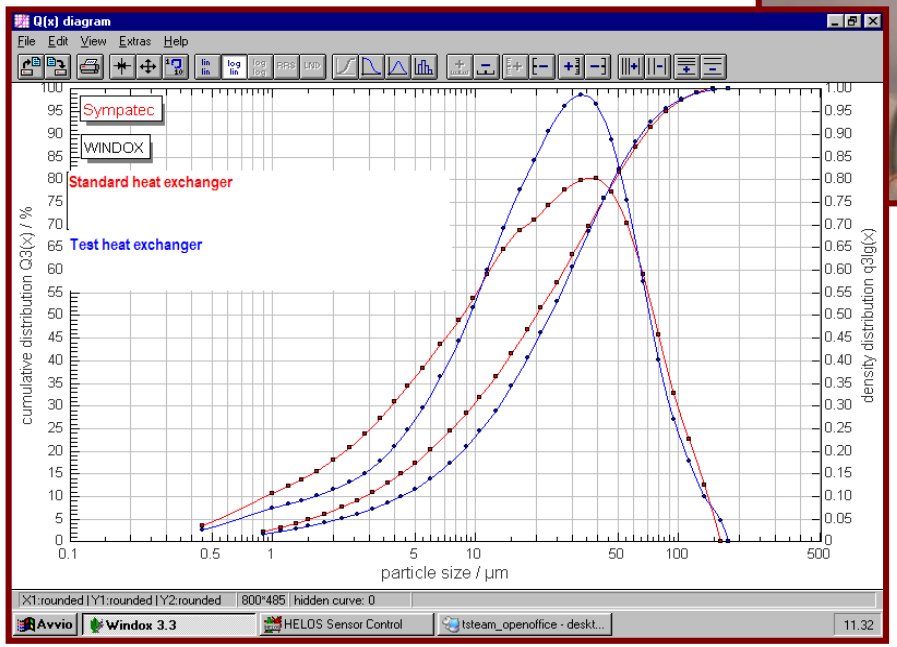


Selection of

Best particle size

vs

Deposition Rate (DR).



Innovative Enamel production system:
Minimize the most extreme sizes of frit particles.

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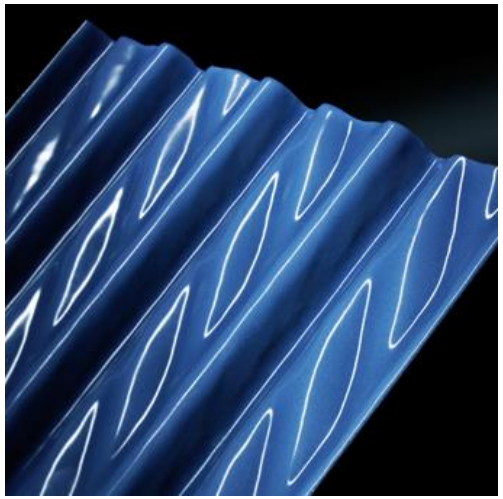
Test carried out on enamel for:



Heat exchanger panels

Boiler

Household appliances

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Samples preparation

Analysis of **applications differences** between enamel powders produced in:

- **traditional** way
- having a **specific particle size distribution**

All samples evaluated with a **laser granulometer** as **distribution curve**

Samples applied on 20 x 20 cm steel sheets bent with a radius of 0.8 mm.

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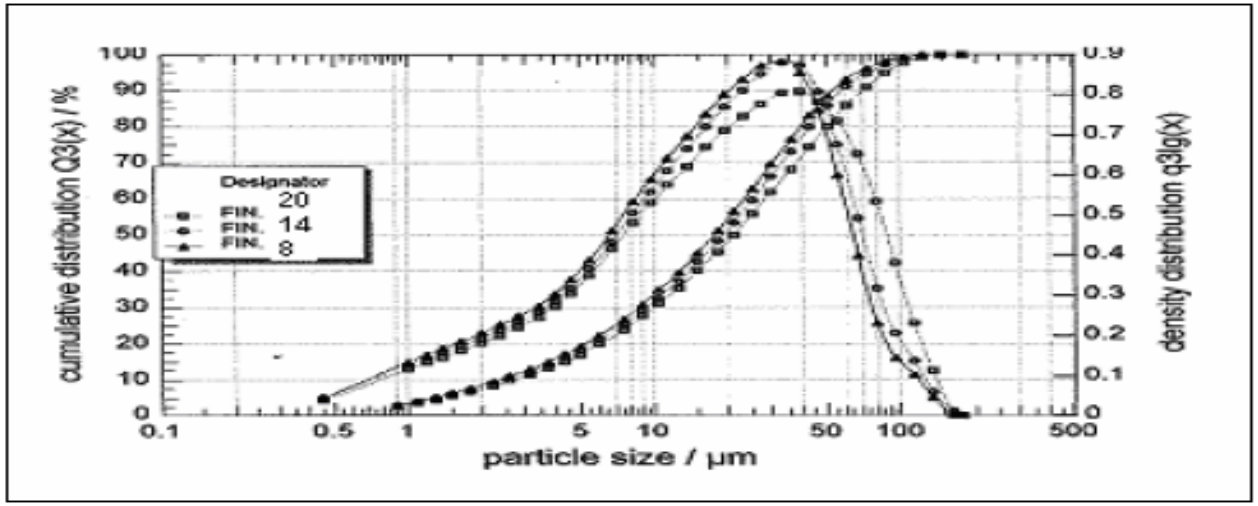
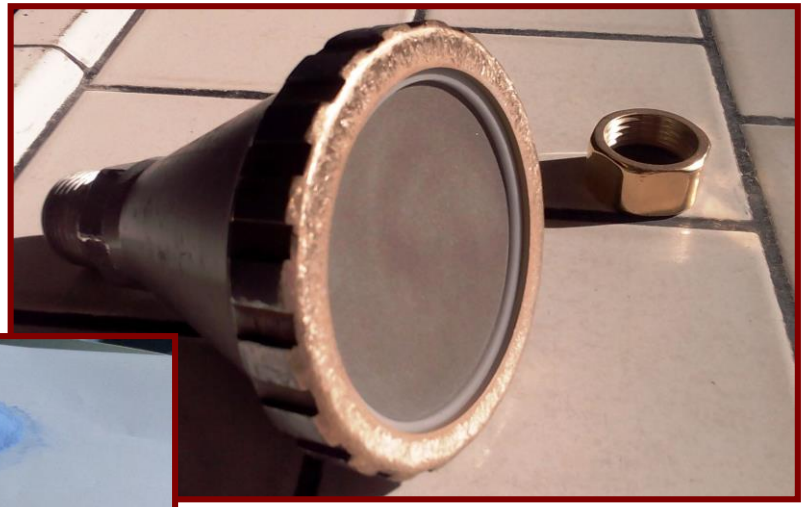
Laboratory test

Enamels powders produced in **traditional way**
different milling fineness (residue on 45 µm sieve as %)

- **8%**
- **14%**
- **20%.**





Test parameters (COSTANT)

1. Distance piece - gun, equal to 30 cm
2. Setting of electrostatic gun: potential difference, air pressure, ratio air/enamel
3. Amount of enamel applied
4. Firing: box furnace 840 °C x 4 min

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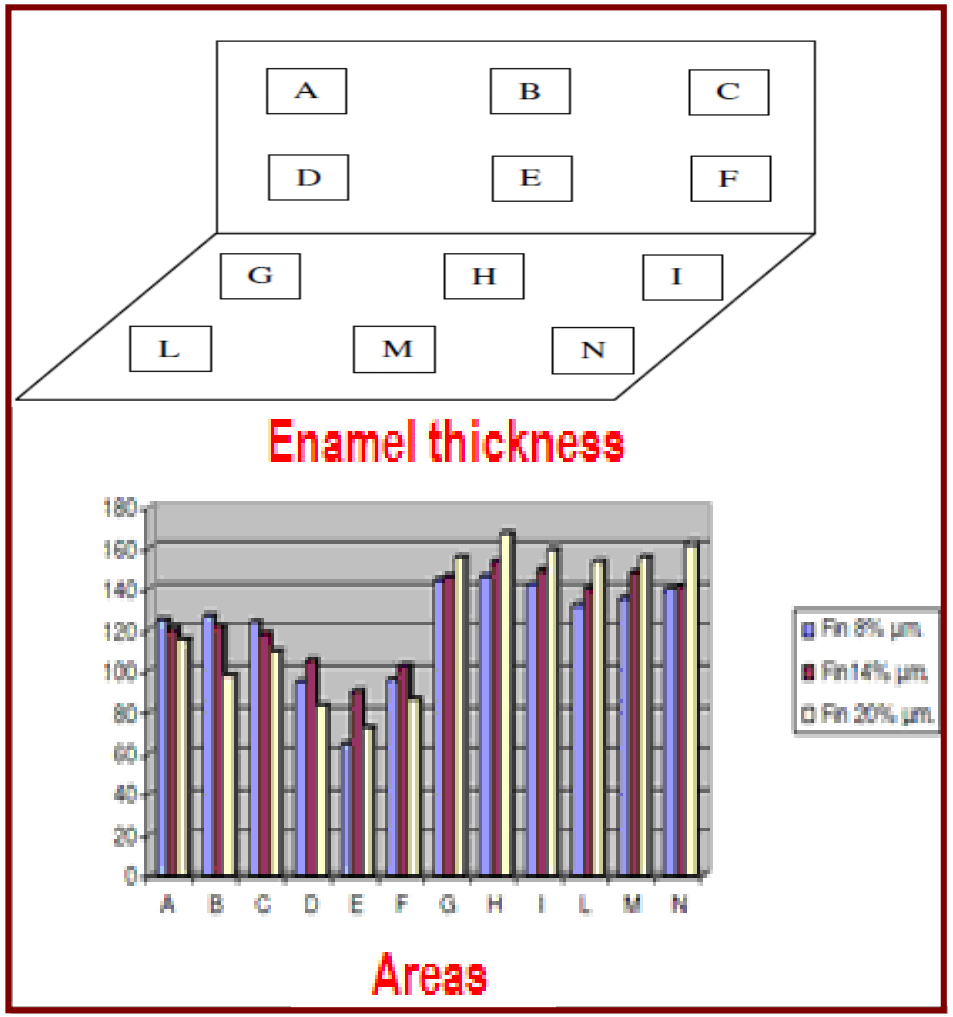
Comment of results

Finer granulometry (8%): accumulating more on peaks and edges

Coarser granulometry (20%): better distribution also in the concave part

Intermediate granulometry (14%): better uniformity with minor accumulations on the flat part and not excessive thickness on the peaks



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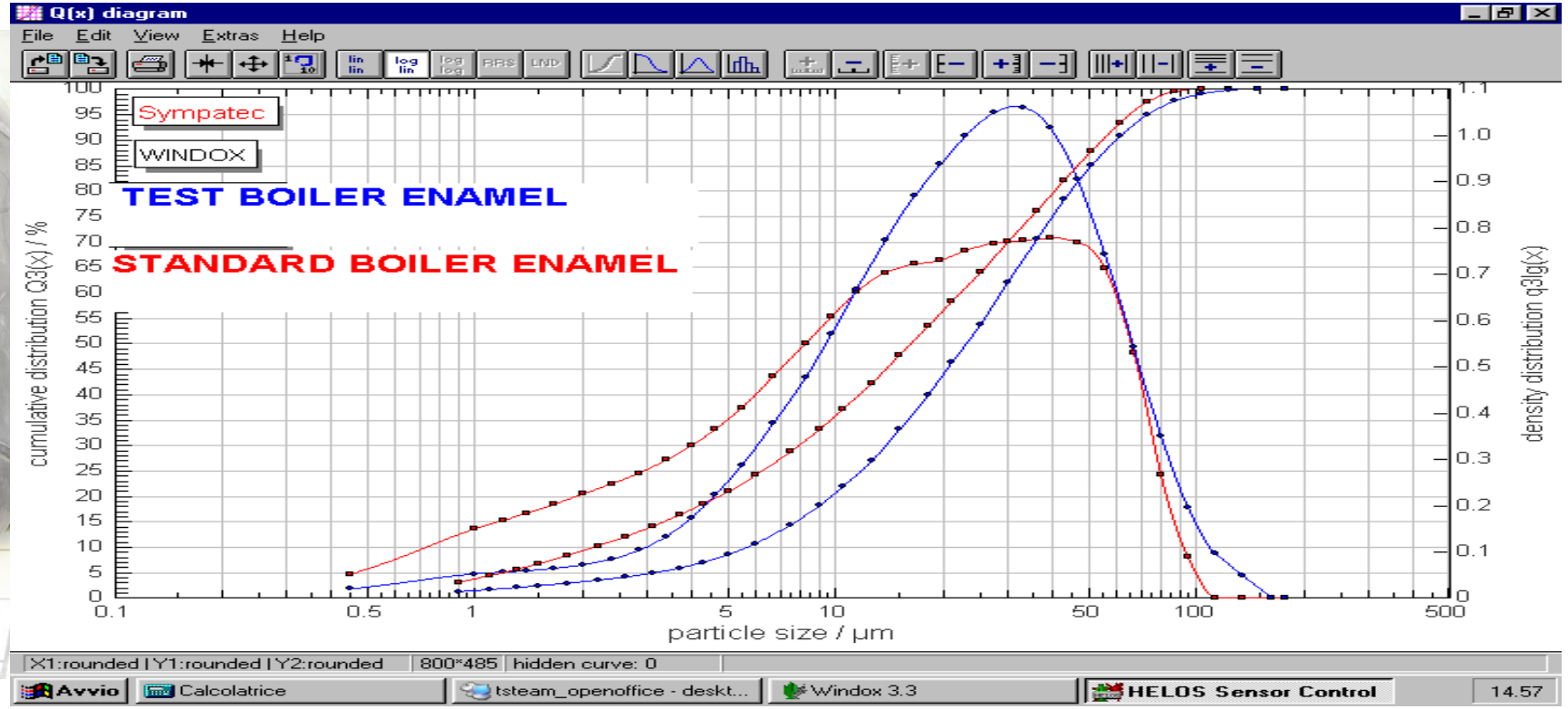
BOILER - Industrial Test



Commercial Enamel Powder vs NEW Enamel **TEST BOILER**

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Application parameters
Enamel Powders for **Boiler**

	Standard Boiler enamel	TEST Boiler
Fineness (D_{50})	18	23
Adhesion	73%	72%
Fluidity	110	120
Deposition Rate	32 g	40 g

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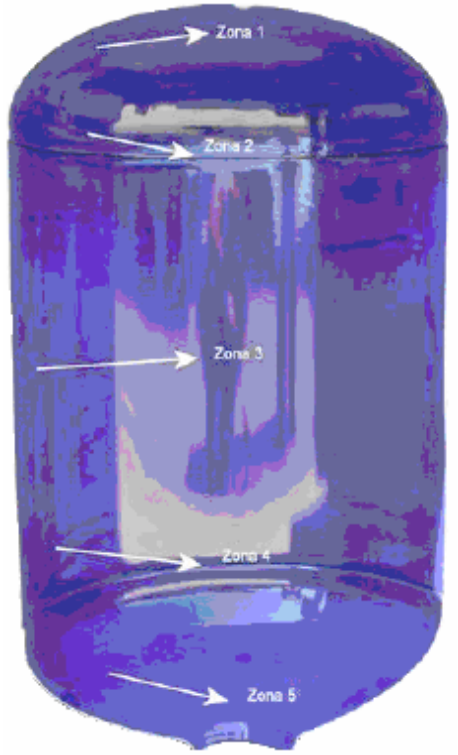
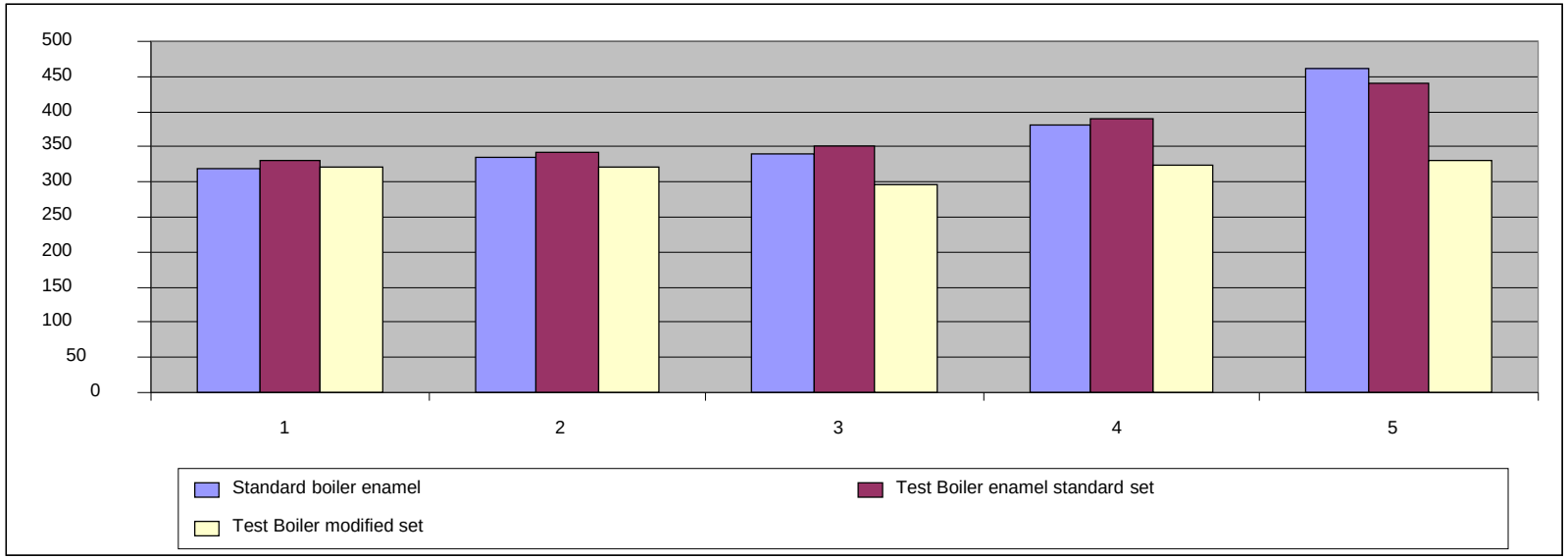
Industrial Testing on 80 lt boilers





Measured thickness average

TEST ENAMEL BOILER:

- **weight** of enamel inside the boiler => considerably **decreased**
- **thickness** distribution => very **uniform**
- Inner surface of the boiler => **lower thickness**

	Standard Boiler Standard Set	Test Boiler Enamel Standard Set	Test Boiler Enamel Modified Set
Enamel weight	807 g	767 g	702 g
Enamel weight reduction	0%	-5%	-13%
Thickness standard deviation	57	45	13

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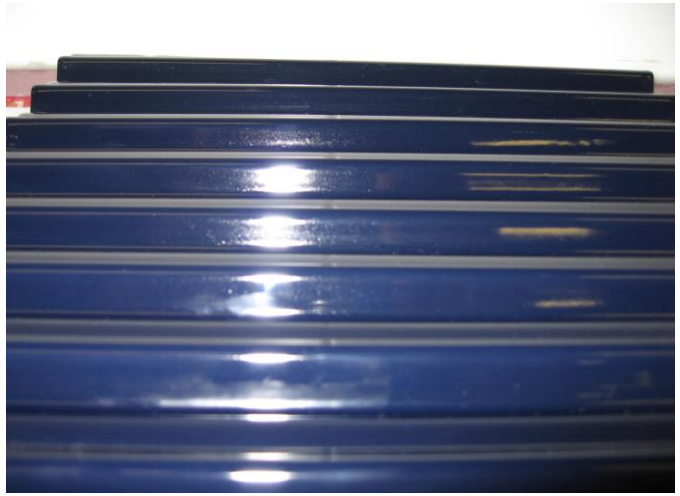
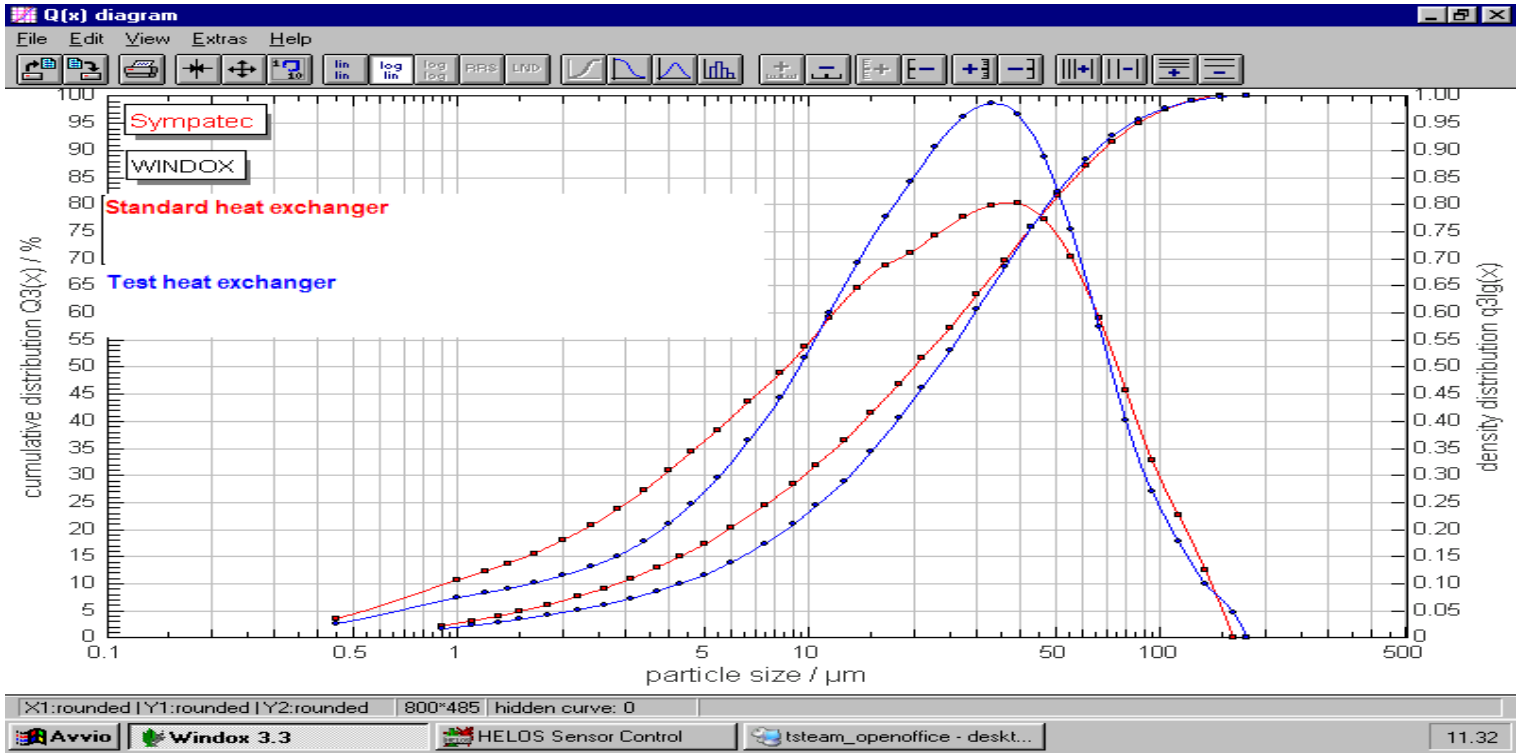
HEAT EXCHANGERS (HE) - Industrial Test





Commercial Enamel Powder vs NEW Enamel **TEST HE**

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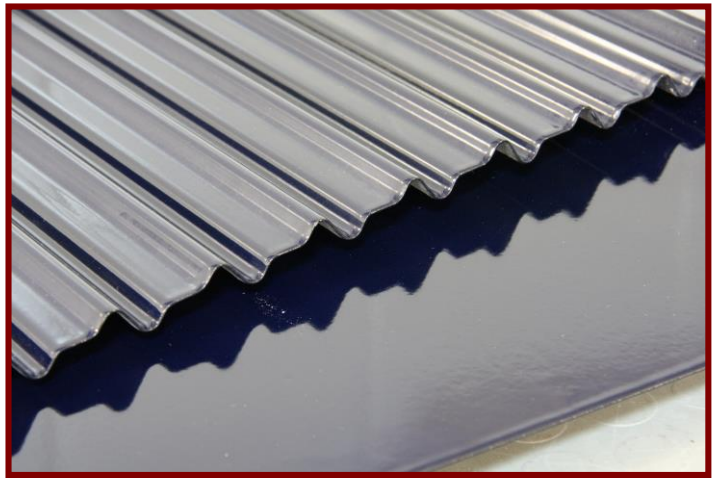
Application parameters
Enamel Powders for **HE**



	Standard HE enamel	TEST HE
Fineness (D_{50})	19	27
Adhesion	70%	70%
Fluidity	100	120
Deposition Rate	30 g	38 g

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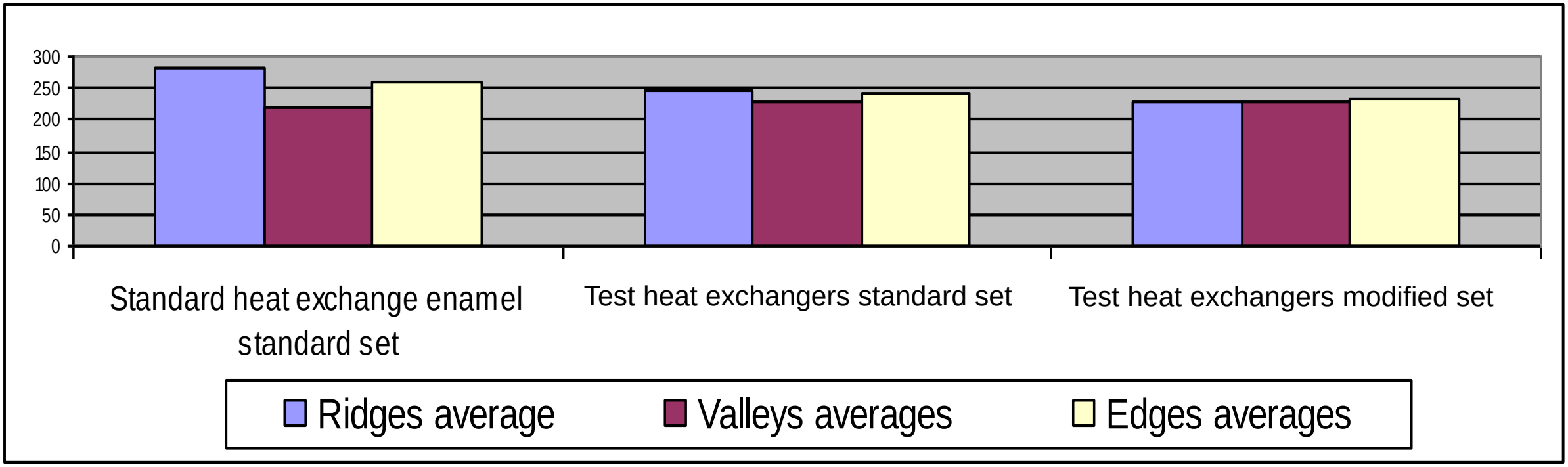

The **thickness** in the various areas of the pieces, became **more uniform**.
The **difference in thickness** between the convex and concave parts, as well as the edges, has virtually **disappeared**.

HEAT EXCHANGER TEST ENAMEL

- **Removed** the most **extreme particle sizes** fractions
- **Increased** powder **fluidity** and **deposition rate**
- More **homogeneous thickness** without accumulations of enamel on peaks and edges.

	Standard HE Standard Set	Test HE Standard Set	Test HE Modified Set
Thickness standard deviation	30,5	45	13

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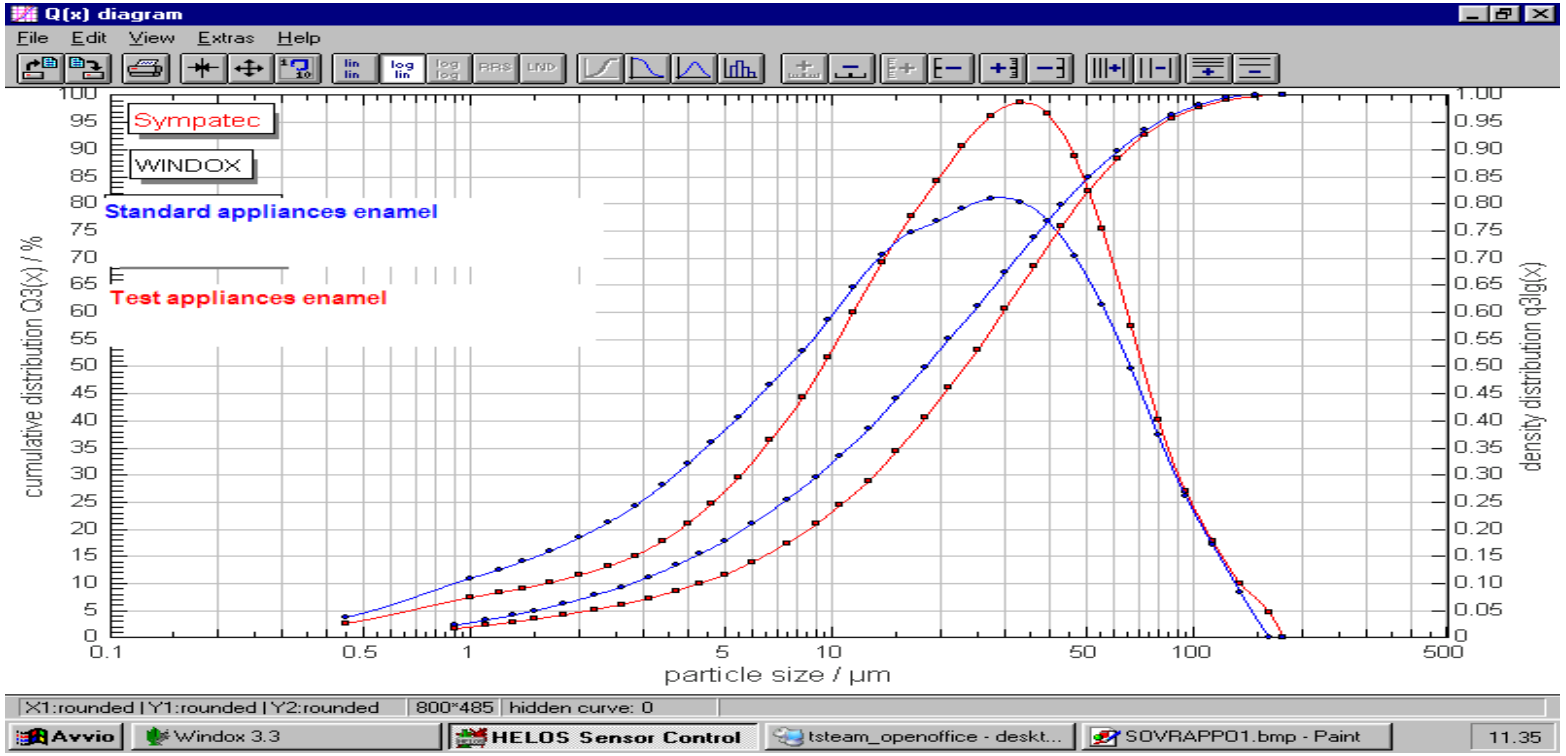
HOME APPLIANCES (RANGES) - Industrial Test



Commercial Enamel Powder vs NEW Enamel **TEST RANGES**

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Application parameters
Enamel Powders for **Ranges**

	Standard Ranges	TEST Ranges
Fineness (D_{50})	19	27
Adhesion	70%	70%
Fluidity	120	140
Deposition Rate	32 g	39 g

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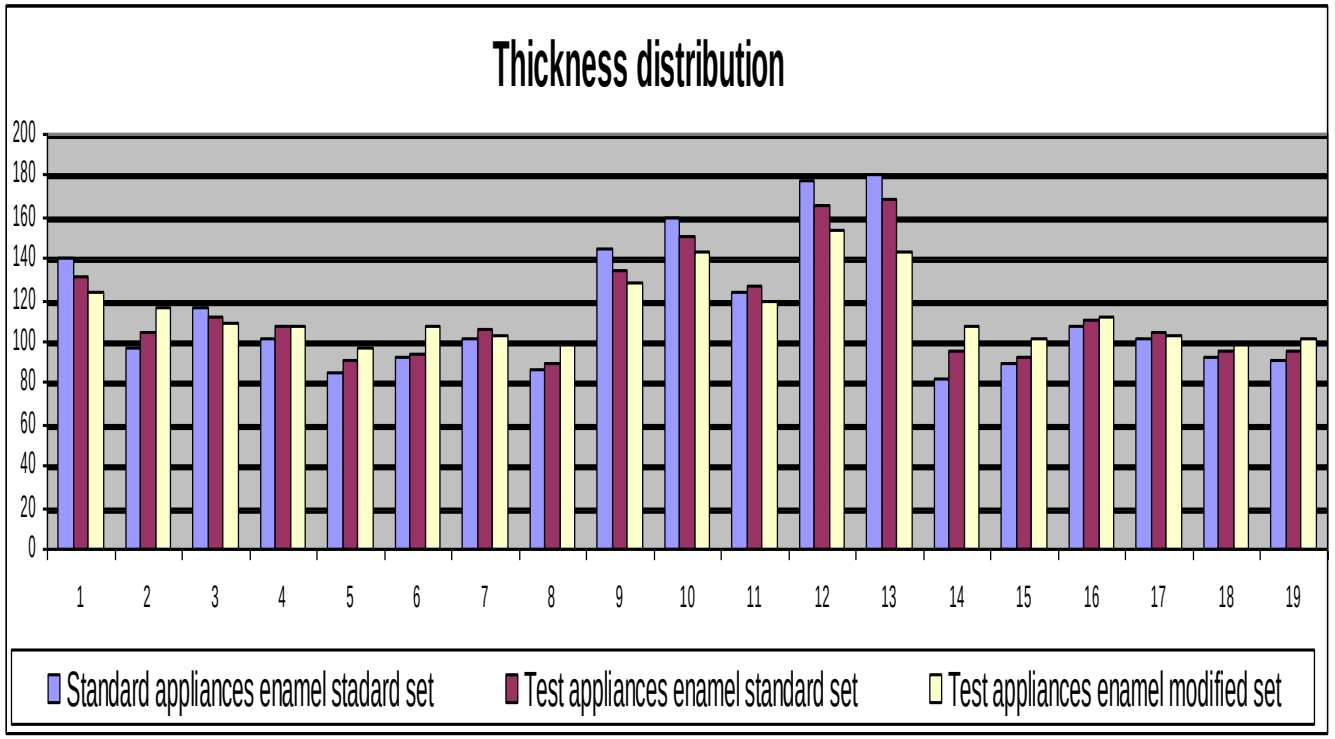

There's an evident **improvement of the thickness homogeneity** using the Test enamel in the Faraday's cage effect most influenced areas

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TEST ENAMEL RANGES:

- **Increased fluidity and deposition rate**
- **Thickness** distribution => more **uniform**
- **Weight** of enamel inside the oven => considerably **decreased**

	Standard Ranges Standard Set	Test Ranges Enamel Standard Set	Test Ranges Enamel Modified Set
Enamel weight	496 g	467 g	448 g
Enamel weight reduction	0%	-6%	-10%
Thickness standard deviation	31,5	25	17

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A more homogeneous distribution of the thickness in home appliances oven enamels, allows us:

1. To achieve a considerable **reduction of the enamel used**
2. To **optimize** manufacturing **costs**
3. To maintain, or even increase, the aesthetic and functional quality of enameled kitchen ovens

CONCLUSIONS

Powder enamel particles size distribution has an enormous importance.

Enamels with a very **selected particle size distribution**, containing thus a very small percentage of the most extreme particles sizes, have **better thickness distribution** in flat and deep moulded surfaces.

A **coating** as **homogeneous** as possible is fundamental for the achievement of significant qualitative and economic benefits such as the **reduction of defective pieces**, the **increase of the functional quality** of the enamelled objects and the **significant reduction of the consumed enamel** for each piece produced.

Of course our research for a powder enamel with high efficiency application properties will require further developments in other fields on which we have already turned our attention.

Thanks for your attention!