Revêtement multicouche hautement hermétique pour implants miniaturisés

Aperçu de la technologie

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Outlines

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2. Challenges for electronic implantable devices
3. Technology overview
4. Case study 1 : Implanted magnet used in miniaturized pumping system
5. Case study 2 : Wireless implanted sensor
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Comelec in key figures & activities

40 years experience in Parylene

Member of watchmaking group **~100 peoples**

2000 run per year

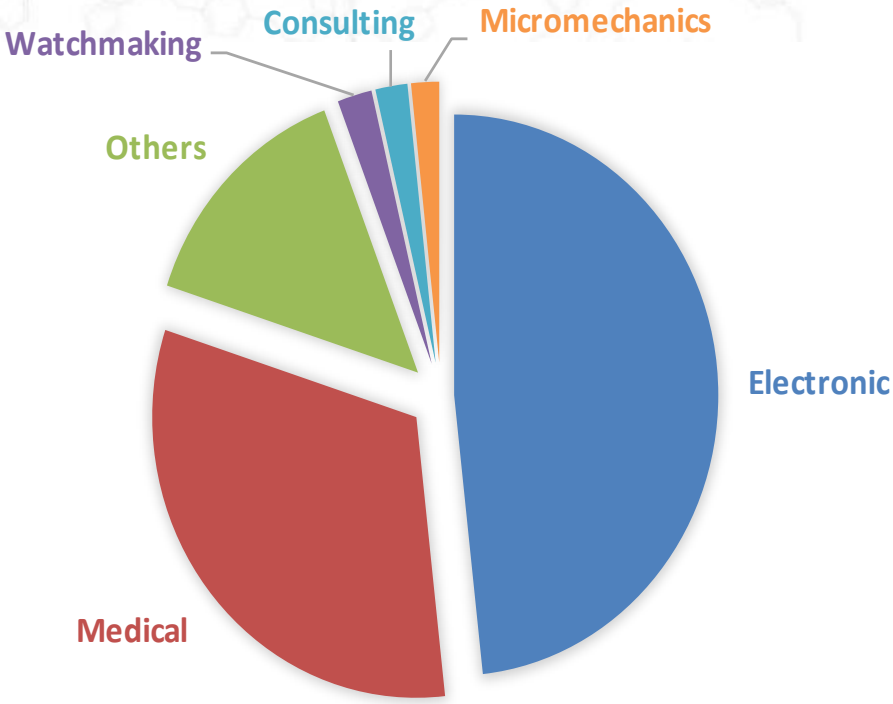
60% to the export

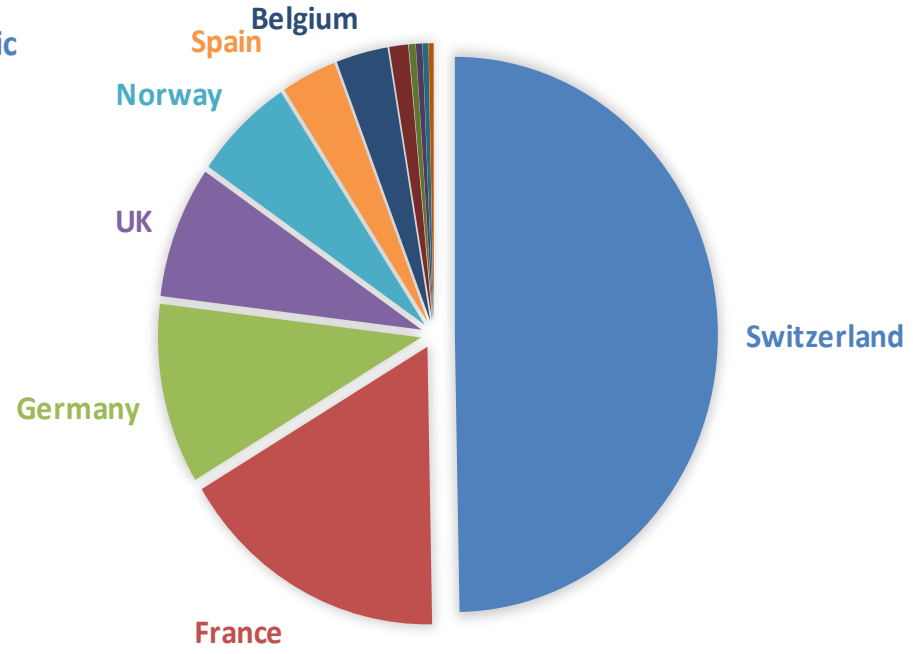
Equipment Sales over **3 continents**

Our services

- Parylene and customized coating service
  - Parylene N,C, D, F-VT4, F-AF4
  - Coating based PECVD and ALD (Al2O3, SiO2, TiO2)
- Masking/Demasking service
- Parylene etching technologies
- Equipment manufacturing & technological transfer
- Distribution of raw material and consumables
- Consulting on specific demand (clean room integration, new process, material,…)

Comelec in key figures & activities





EU R&D Program

- ✓ Innosuisse, Swiss funded projects
- ✓ European projects

2007 **2010** **2015** **2018** **2021**

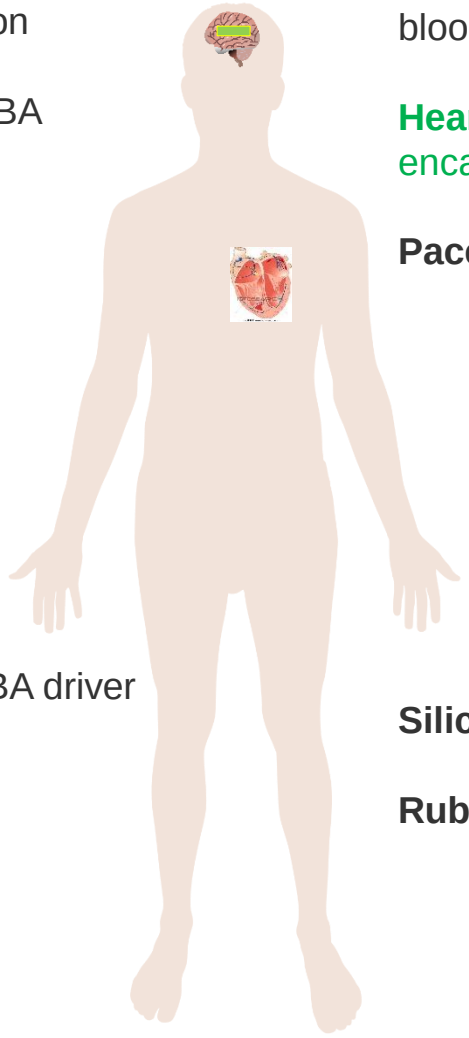
Medtech applications

Deep brain stimulator: Electrode protection

Therapeutic Bioelectrode: Coating of PCBA

Valve: Coating of sensitive magnetic alloy

Tips: Biocompatible coating



Artificial heart: Protective layer from blood contact

Heart pump: Protective layer and encapsulation

Pacemaker: coating of the PCB

Bone implant sensors: Protective coating

Glucose sensors: Coating of PCBA

Liquid pumping systems: Coating of PCBA driver

Earing aids: Coating of PCBA

RIFD chip: Glass tag coating

Silicone prosthesis: Anti-friction coating

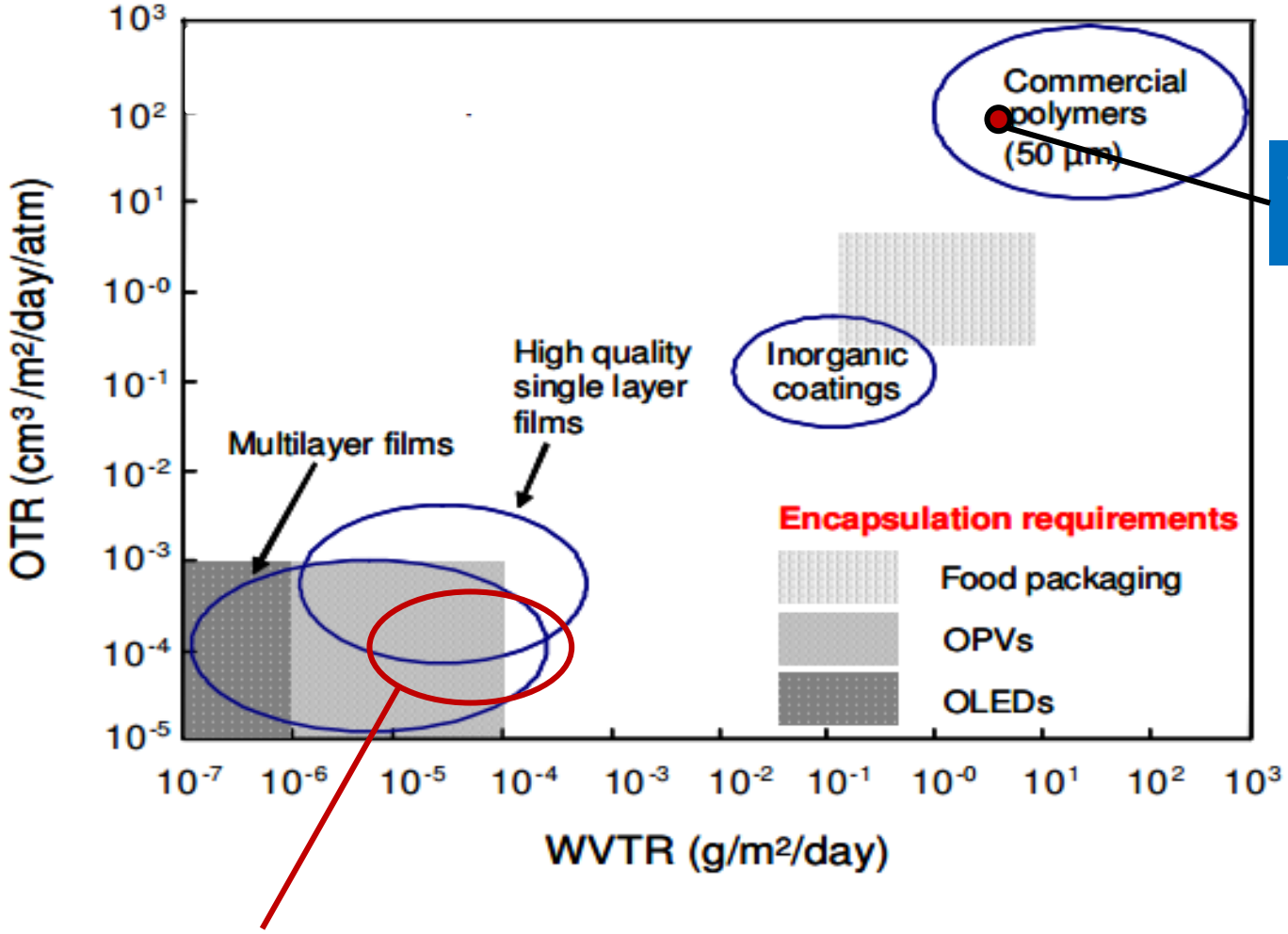
Rubber piston: anti-sticking

Challenges for active implantable devices

- Miniaturization leads to high density of components per surface unit and a risk of current leakage.
- Development of MEMS and microfluidic systems enable a fast and precise diagnostic. However their sensitivity to particles and physiological fluids decrease dramatically their effectiveness.
- For a fast connectivity, the component used (eg : RF antenna) thin packaging is required.
- In advanced electronic implants, several material need protection against leaching.
- For long term implant (More than 1 year), the resistance to highly conductive and corrosive physiological fluids becomes a crucial issue.
- Bacterial colonization is also a topic of great concern

The encapsulation layer is key component to overcome these challenges!

Challenges for active implantable devices



Parylene C 25µm :

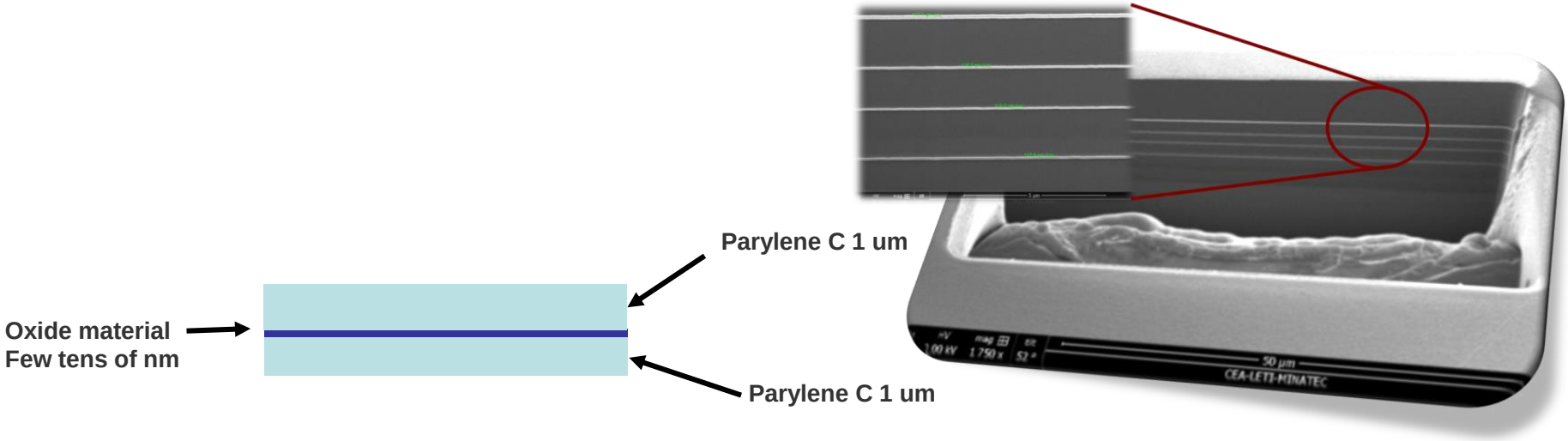
WVTR => ~ 7 g/m²/day
O2TR=> ~ 120 cm³/m²/day

Targeted performance for long term AIMD

Technology overview : Principle

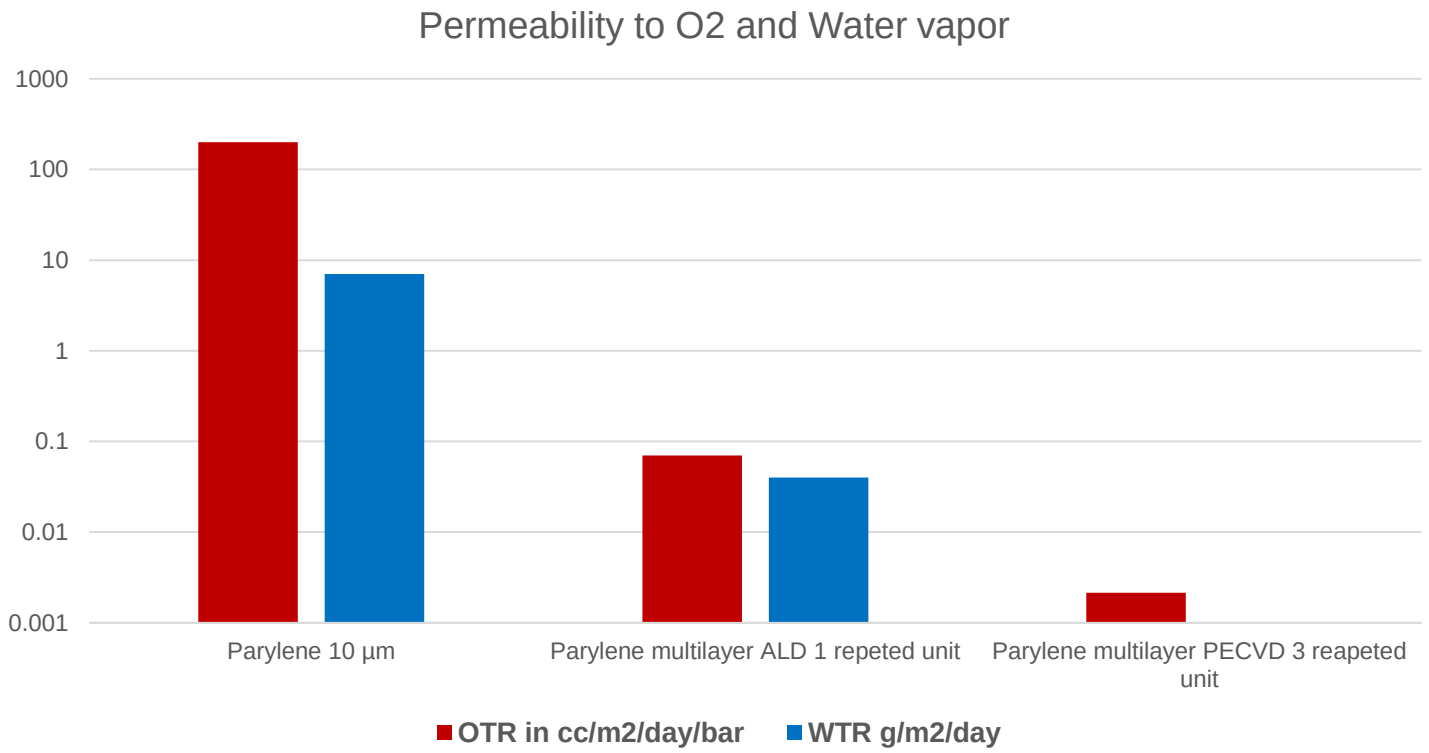
Why combining Parylene with oxide material? The synergetic effect…

- Parylene C barrier properties are limited
- The oxide material lead to weak point that let molecules diffuse
- The combination lead to full encapsulation of the oxide material and stress dissipation.
- The single sandwich can be repeated many times if necessary



Results: Barrier properties with different combinations

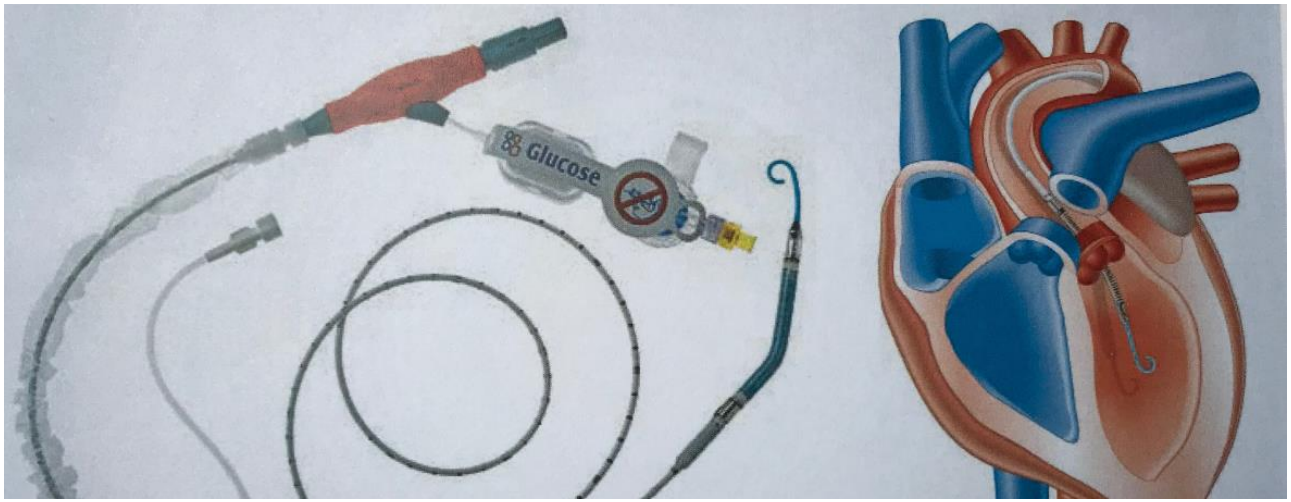
Quantitative result : OTR, WTR



Case study 1: Magnet used in miniaturized pumping system

Context :

- Magnet are made of Neodymium Iron Bore Alloy which is extremely sensitive to conductive liquids
- The product is in direct contact with blood and other potential physiological fluids
- **Magnet need to resist <u>over 50 days in salt solution</u> at room temperature without any sign of corrosion**



Example of magnet

Case study 1 : Ferrite and magnet used in pumping system

Test results :

- A multilayer structure has been proposed based on ALD Aluminum oxide and Parylene C.
- The multilayer was compared with the current solution based on Parylene C 15 µm and a single ALD layer

✓ ALD single layer
✓ Corrosion after 2 days

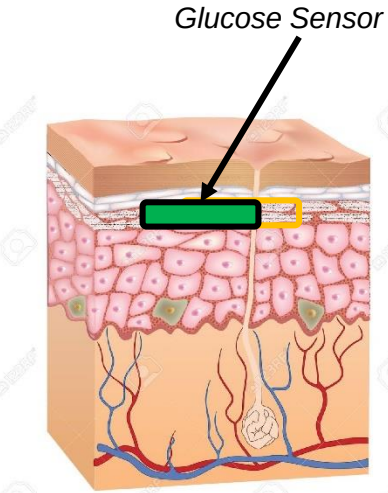
✓ Parylene C single layer
✓ No corrosion after 50 days
✓ Some microscopic spot could be observed

✓ Parylene C ALD multilayer
✓ No corrosion after 50 days

Case study 2 : Wireless implanted glucose sensor

Context :

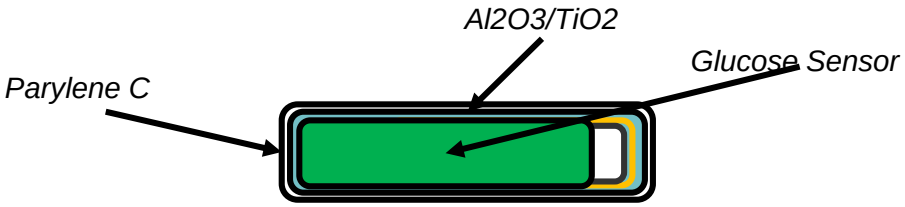
- The traditional metallic cap are not allowed due the presence of antenna and the need to access directly to the protein.
- A thin encapsulation layer is needed to do not disturb the signal and the RF communication.
- The implant need to stay operational more than 1 year
- A current solution based on Parylene 20 µm is working for up to 3 months.



Representation of glucose sensor

Test results :

- To extend the device shelf life, a multilayer coating based on Al2O3/TiO2 + Parylene C 22 µm is proposed
- According to simulation, an extension of the shelf life by three years is expected.



Structure	Time where a defect is detected After aging 55°C in PBS	Extrapolation @ 37°C in vivo
Parylene C 22 µm	3 weeks	3 months
Parylene C/Al2O3/TiO2	12 weeks* (no defect detected, test under progress)	12 months*
PVDTiO2/ ALD Al2O3/TiO2/Parylene C	6 weeks	6 months

Conclusions and Perpectives

- This multilayer high barrier technology open the door for new range of application where thickness/permeability ratio is critical in AIMD especially when sensors are involved
- It keeps the same advantages of the well known Parylene conformal coating at a thinner layer
- Performance can be tuned by increasing the number of layers
- Biocompatibility can be easily demonstrated thanks to Parylene top coating
- Cost effective process based on well-established technologies
- Comelec SA Parylene Coating is ready for new cooperation projects

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THANK YOU FOR YOUR ATTENTION!