

MetaPaper - Cellulose sheets to filter electromagnetic waves

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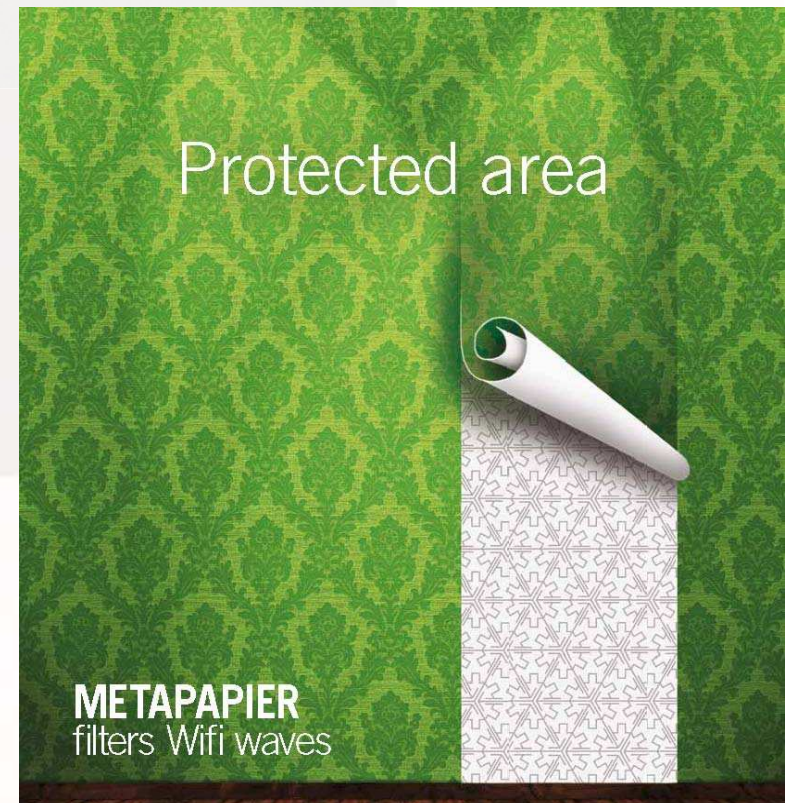
Paul Piette (Printing)



Cooperation with two laboratories:

IMEP: Dr Tan-Phu Vuong

LCIS: Dr Pierre Lemaitre-Auger



Summary



- **Context, Objectives, possible use on market and created Value**
- **Technology used**
- **Base of efficiency**
- **First measurements**
- **Conclusion of laboratory printing (plaster, wood, glue, wallpaper)**
- **Industrial printing**
- **Conclusion for industrial printing**
- **Demonstrator**
- **Conclusions**

MetaPaper - Cellulose sheets to filter electromagnetic waves

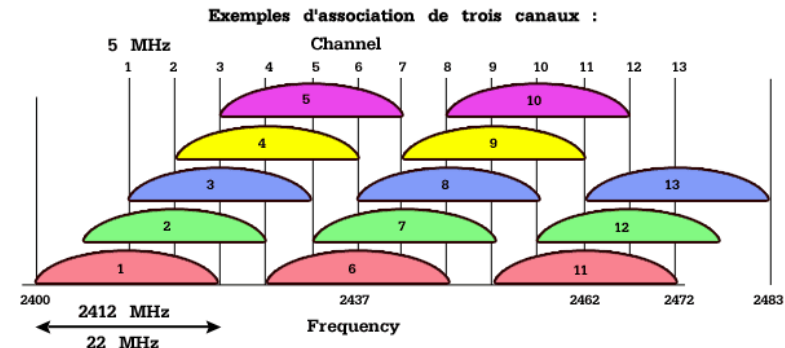
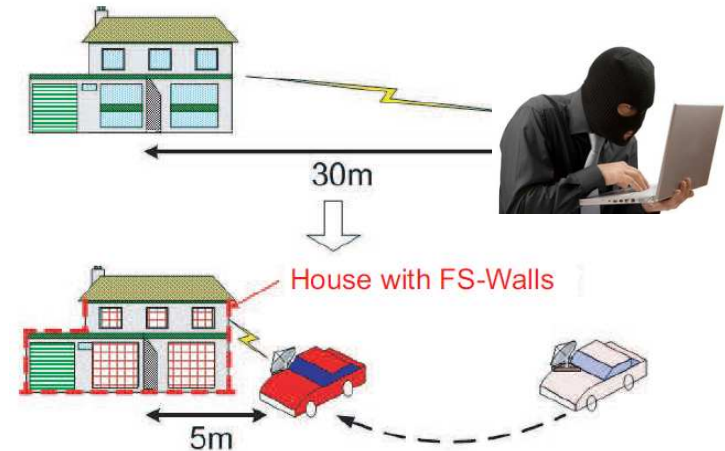


Context

Surrounded by RF:



- May have a detrimental effect for **health**, or simply on quietness
 - More and more alarming reports
 - People are wishing more protection
- **Security of data** (companies or home network protection for wifi)
- **wireless network efficiency** (better sharing of wireless channels..)



Scientific publications on “health and waves”

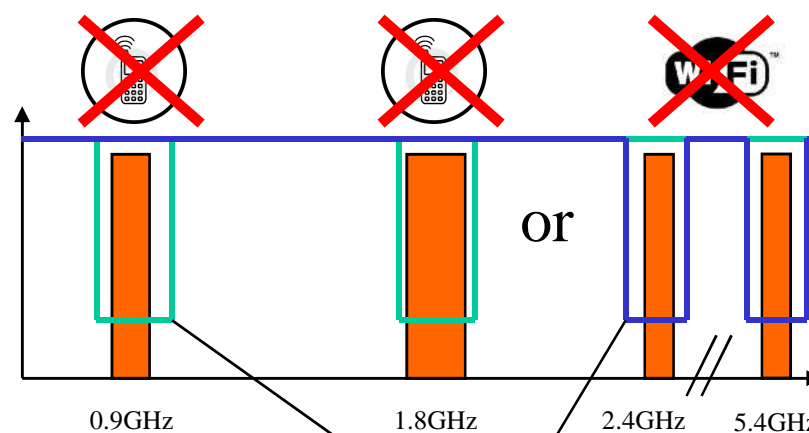


- **Report “*INTERPHONE*” in 2005 for OMS :**
 - “Chance” to get a brain cancer “increases of 40% for mobile phone users (30minutes by day during ten years)”
- **“*BIOINITIATIVE*” REPORT in 2007 validated by EEA (European environmental agency) and by the European parliament :**
 - Effects on health of Wifi, mobile phone, UMTS, DECT, etc.
 - ALARMING REPORT OF 600 PAGES
- **Some justice judgments which consider that health problem can be due to electromagnetic waves**
- **2011 : Classification by OMS of mobile phone as “substance that can cause cancer”**



Our goal...

- To design, manufacture and test **wallpaper** to filter **selectively** electromagnetic waves
- We do not want a Faraday cage and related installation problems!
- Wifi and GSM types



Filter that show perfect attenuation in function of frequency

Markets



- **HEALTH**

- For **reduction** of exposure to electromagnetic waves

- **DATA SECURITY**

- To offer the possibility for some companies or for public to improve the security of their data in case of the use of Wifi,

- **INCREASE WIRELESS NETWORK USES**

- To offer to the public the possibility to use, with normal performance and not with a degraded one, their Wifi communications

- **TO OFFER LOW COST MATERIAL TO CREATE QUIET SPACE**

- cinema, hospital, theater, etc.

NB: to stop a technology, MetaPaper might be used by CEM professional company in addition to other device like filters

- *Wallpaper applications:*

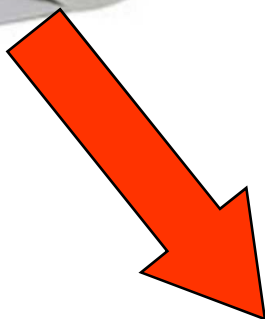
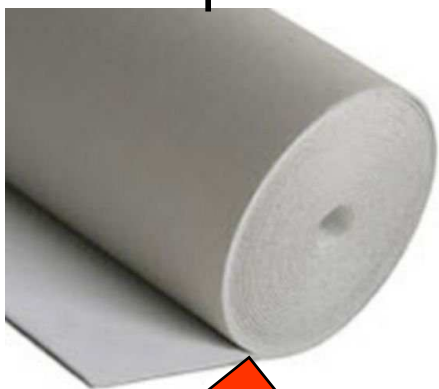
- France only uses about 60 million rolls of wallpaper/year (20 million produced)
- Estimation of the market share for the anti-wifi-gsm wallpaper : to be about 1%

✓ **10€/m² => 30 M€/ year only for France**

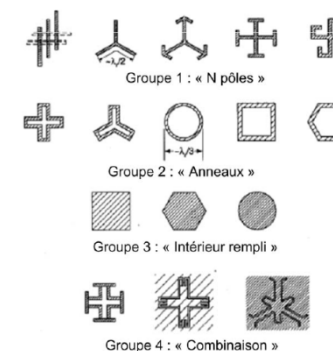
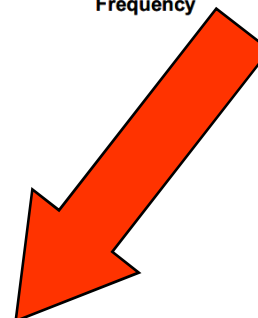
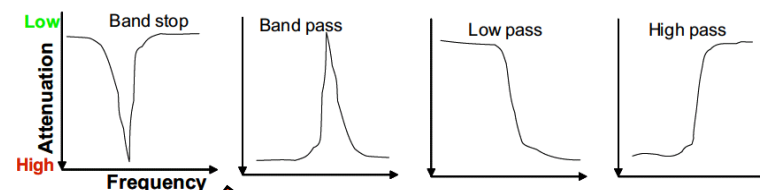
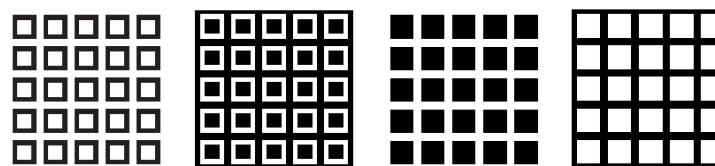


What is MetaPaper ?

Paper



Frequency Selective Surface



Frequency Selective Surface



- **What's Frequency Selective Surface (FSS)?**

- **Utility** : Spatial and frequency filtering
- **Main interest**: 2d structures
- **Individual patterns: exemples**



Groupe 1: Centre Connecté ou N-poles



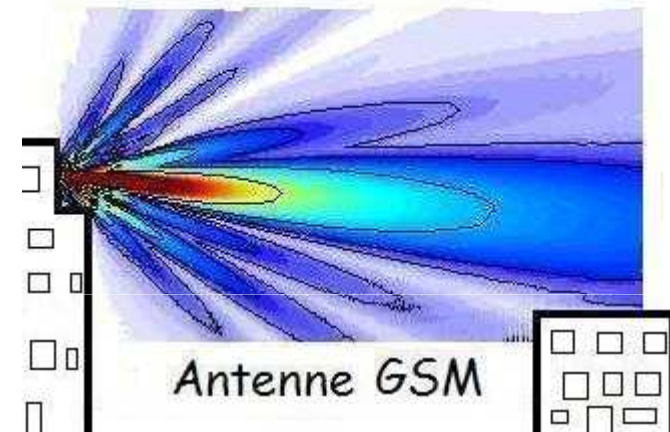
Groupe 2: Les Boucles



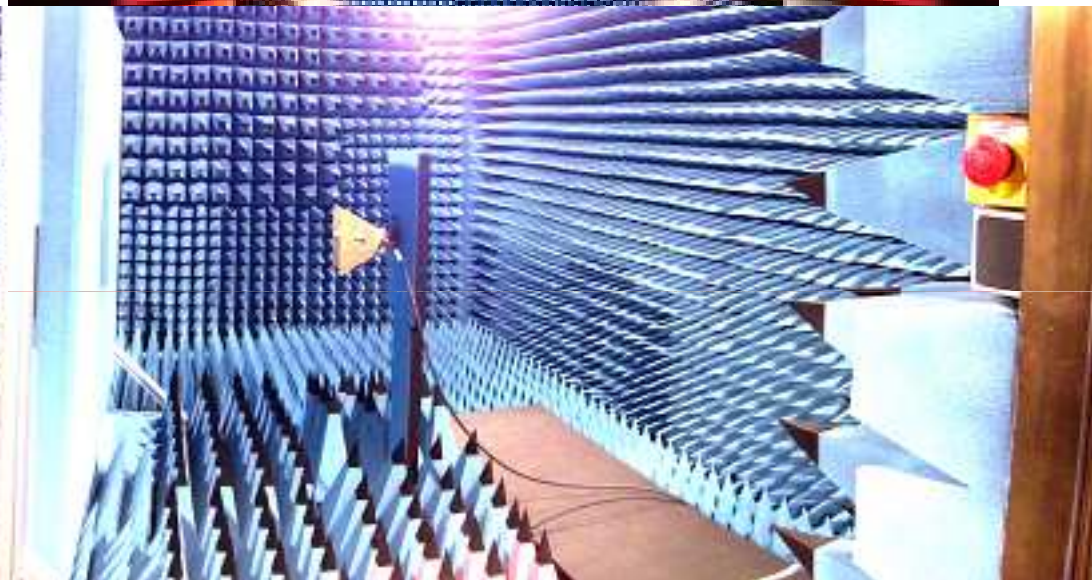
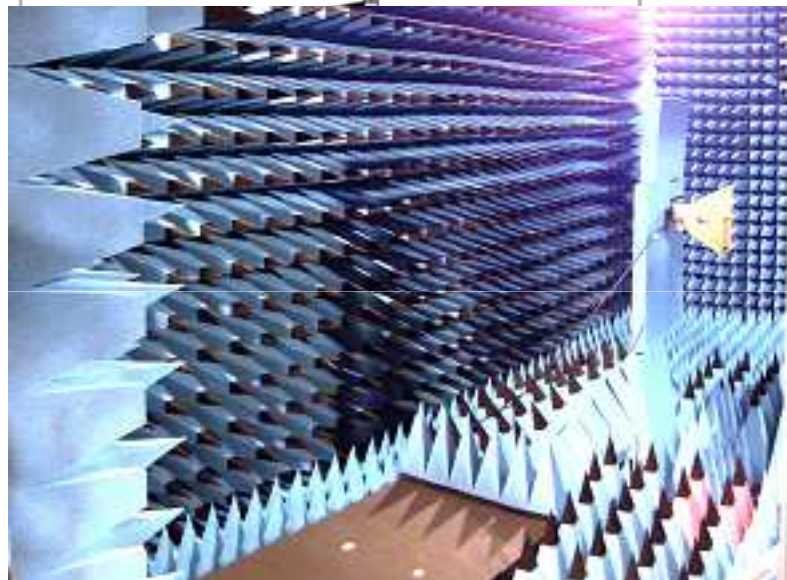
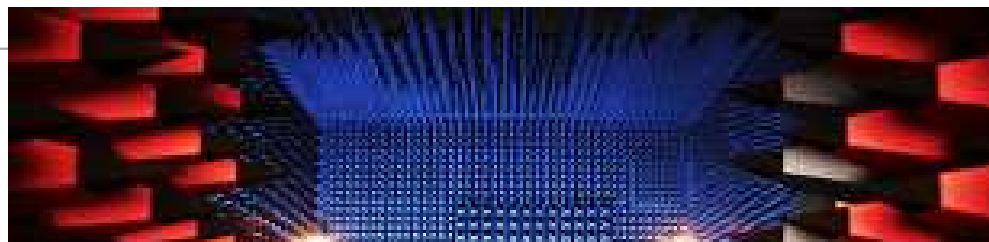
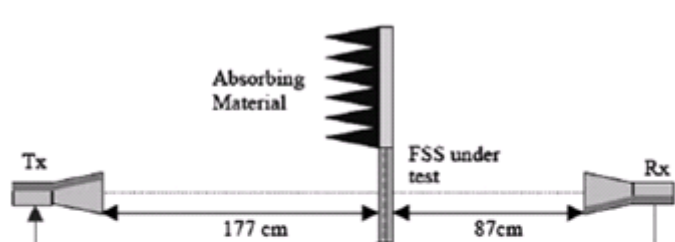
Groupe 3: Intérieur Solide ou Plaques



Groupe 4: Combinaisons



Bench for measurements in anechooid chamber



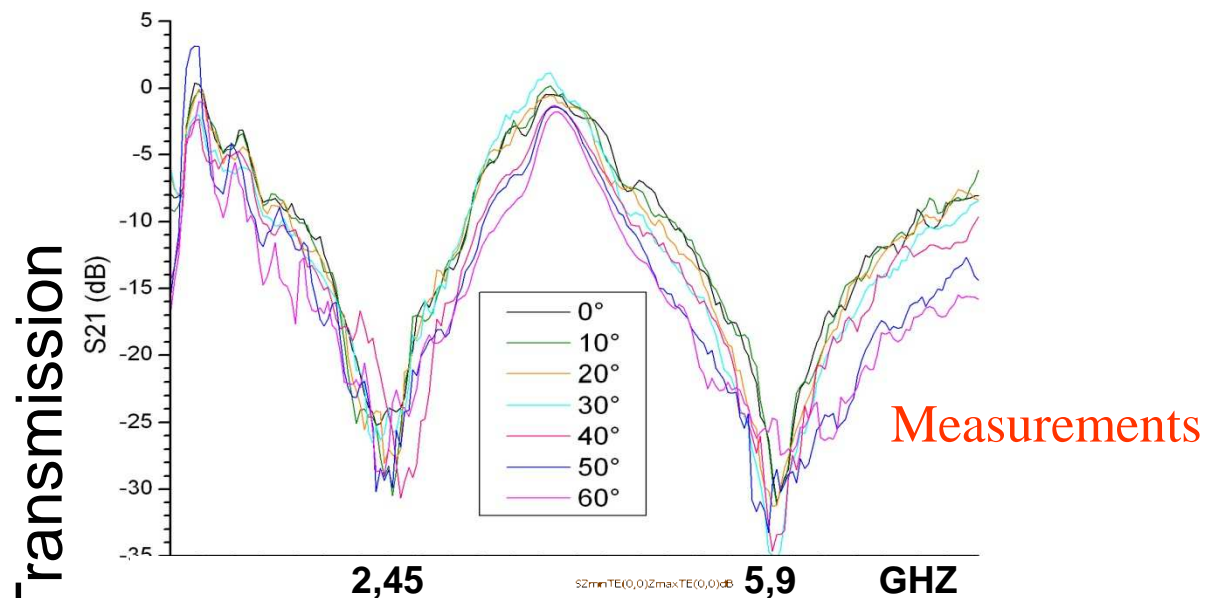
Implication of two laboratories: IMEP and LCIS



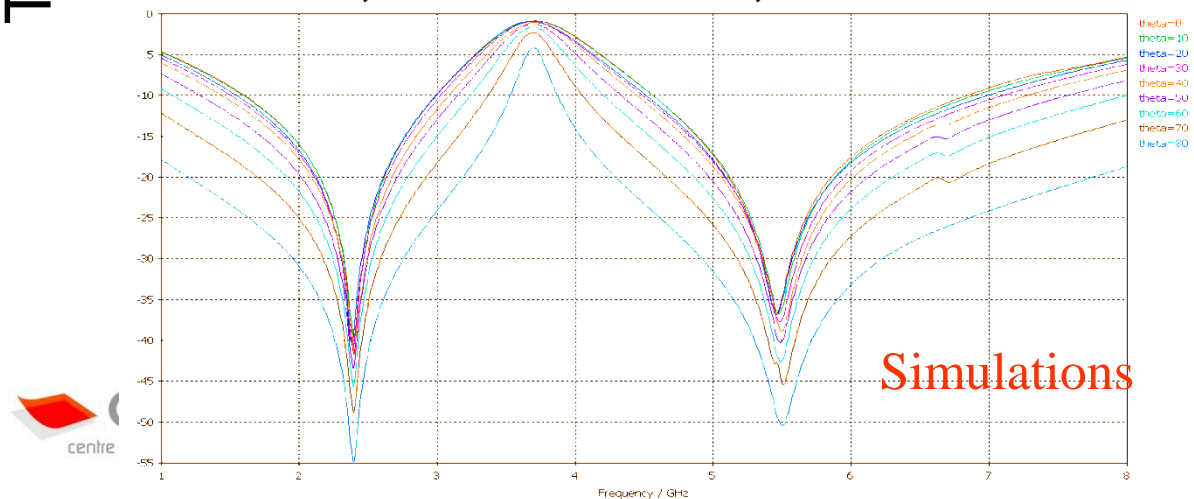
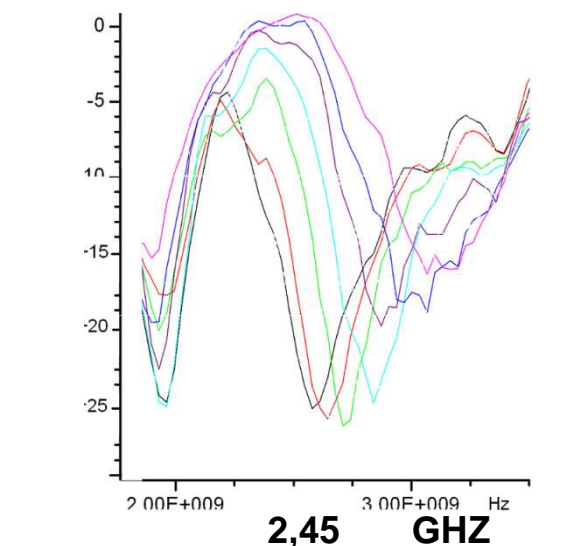


Confirmation of simulated results by measuring

● CTP's Structure



ETRI's Structure

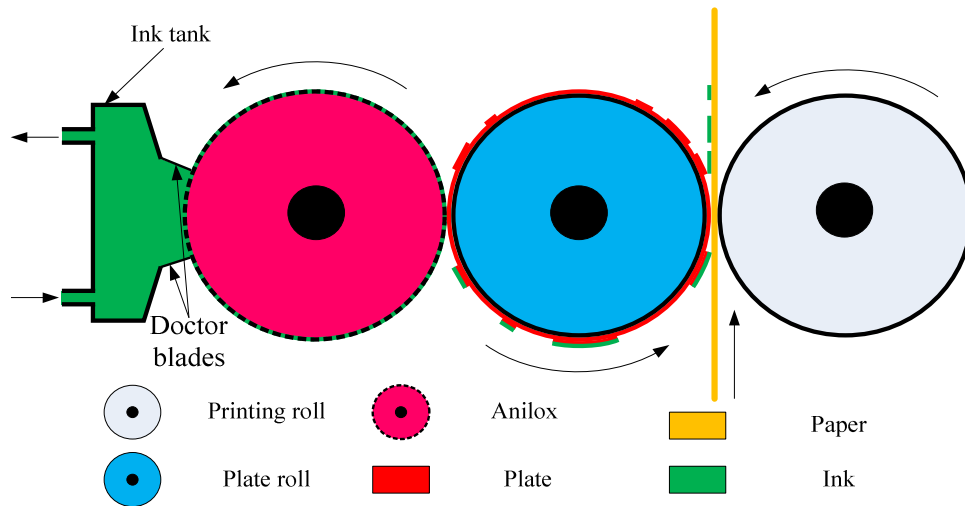


Industrial protection



- **This structure is patented (CTP): N° 10/53217**
“SURFACE ADAPTÉE À FILTRER UNE PLURALITÉ DE BANDES DE FRÉQUENCES »
- PCT extension on going : August 2011 => February 2013
 - After February 2013 : need to choose specific country

Printing technology used

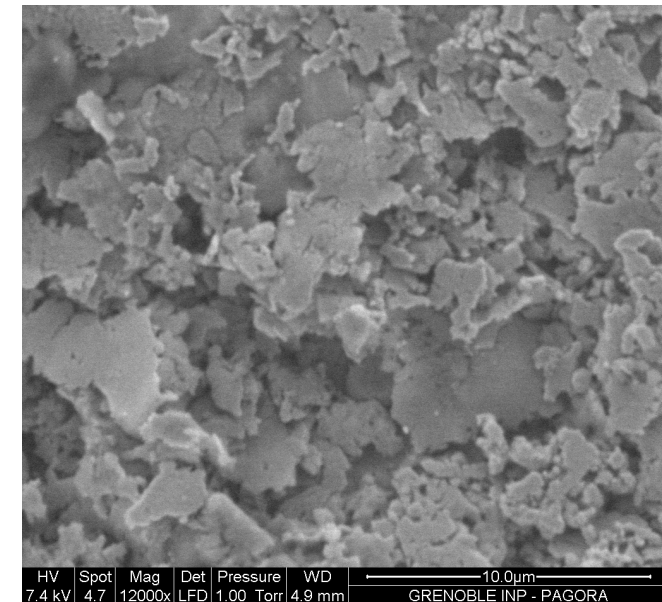


Flexographic printing :

- Already used for wallpaper
- High speed possibility (up to 30-50m/min with conductive ink)
- Up to 4-5 μ m ink deposition

Flexographic conductive ink used :

- Sun Chemical ink optimized for paper
- Water based ink with silver nano-particles
- No sintering process necessary
- Conductivity of 10^5 S/m measured after drying

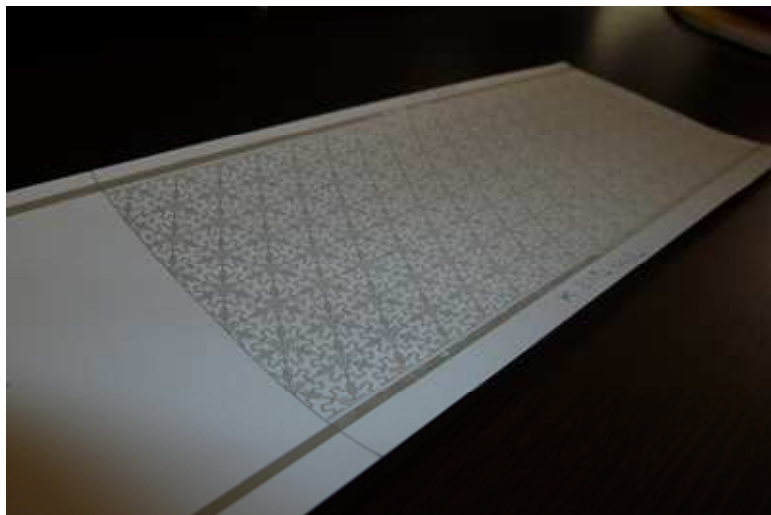


Laboratory Printing



Semi industrial pilot (developed by CTP) :

- For flexographic printing production sheet to sheet
- For optimization of printing parameters before industrial printing:
 - Size of anilox
 - Pressure applied
 - Drying conditions
 - ...



Printed wallpaper samples :

- Strips obtained on 30cm×10cm wallpaper
- Possibility to assemble strips
- Wallpaper used is coated on the printed side and is an industrial reference



Conclusion on laboratory printing

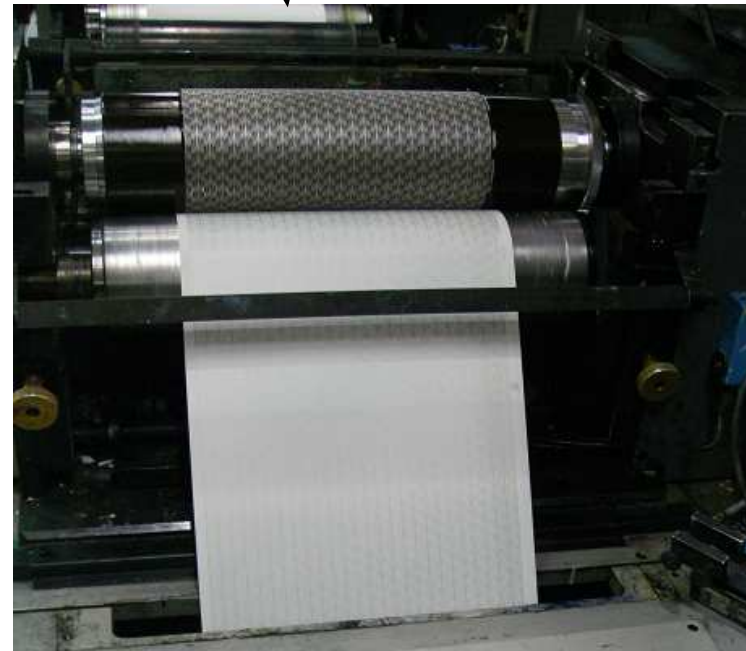
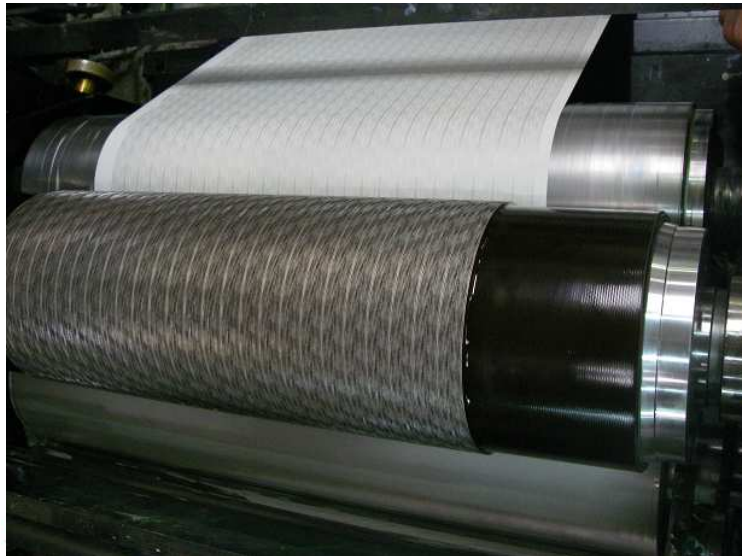
- **MetaPaper is printable on industrial paper and has the same efficiency than the predicted one**
- **No problem with use of sub layer on plasterboard or on wood (painting)**
- **No problem with the use of glue**
- **No problem with the use of laminated wallpaper (Took into account in the design)**
- **Attenuation of 20dB can be easily reached (hundred factor : 99% of attenuation)**
- **Repartition of ink on the printed pattern => possibility to do better (optimization), so a better efficiency of filtering**

Industrial printing

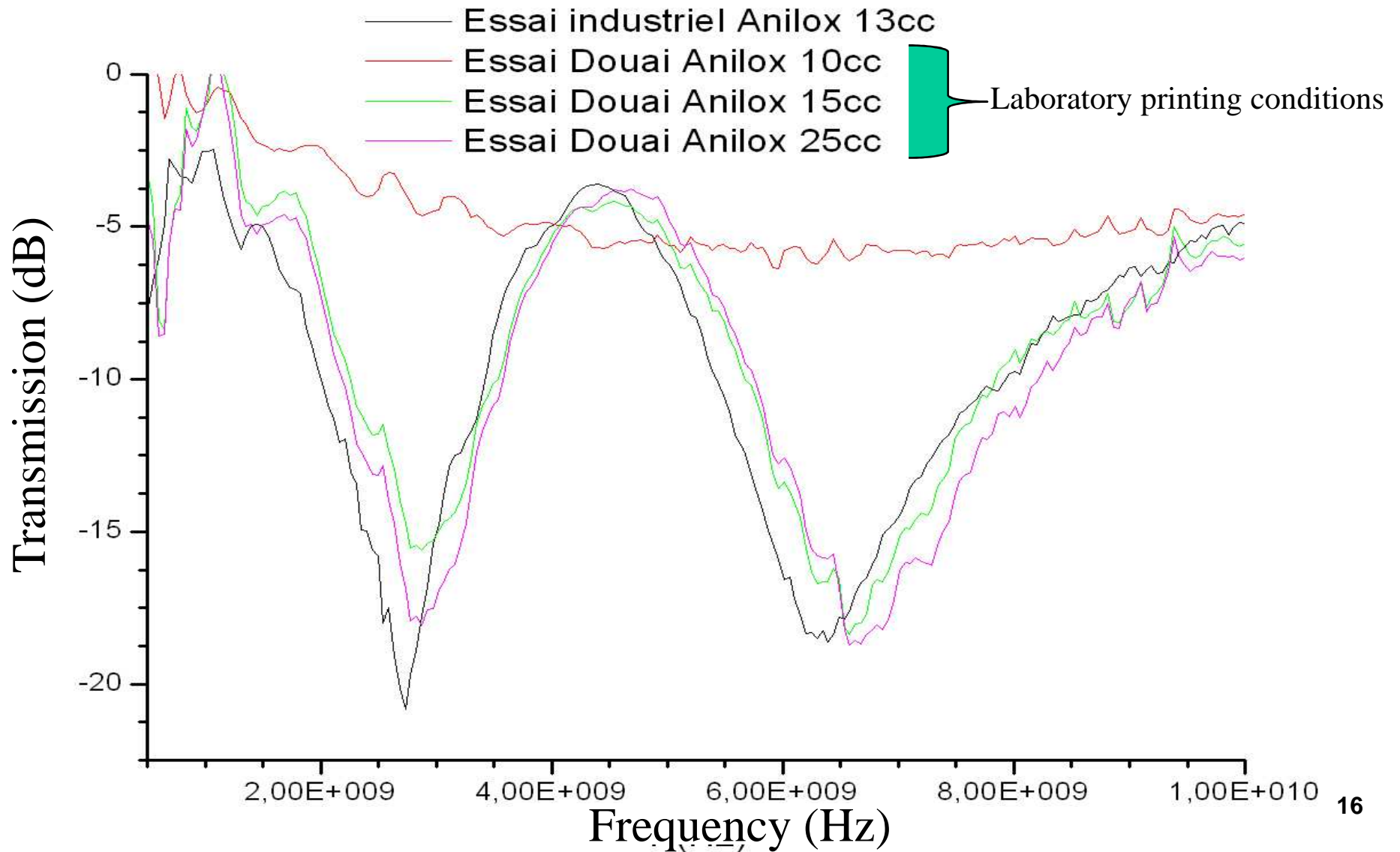


Optimized industrial printing :

- Speed : near 10m/min
- Compromise size of anilox/pressure applied
- Printing presses from a food packaging printer



Comparison between laboratory and industrial trials



Conclusion for industrial printing



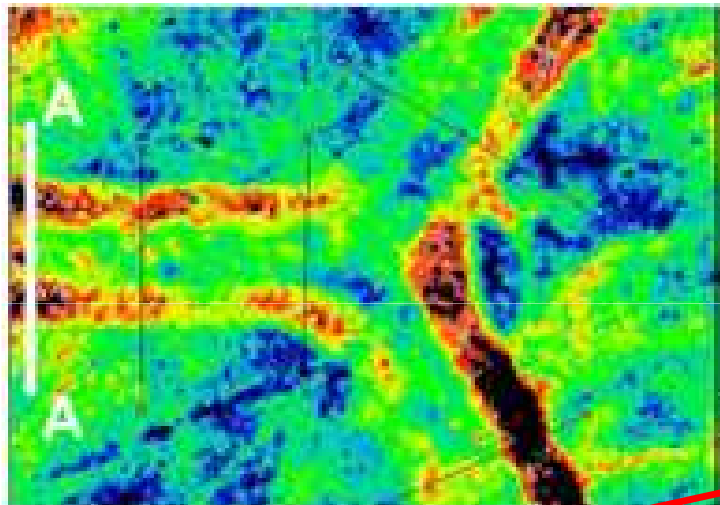
- **With optimized anilox, industrial trials show nice performances. Good news: **two times less ink** than in laboratory conditions provides **better performances!****
 - **Possibility to increase performance** by increasing quantity of ink without creating interconnections
 - **Possibility to reduce production cost** by decreasing the volume of ink used for the same performances



Printing quality results – Halo effect

Adapted Optical interferometry measurement developed by CTP :

} Developed for roughness measurements of paper => ink diffused inside the paper can't be seen



Blue color = low thickness
Red color = high thickness

a)

b)

On first laboratory samples (size of anilox = 25cm³/m²) => damageable halo effect :

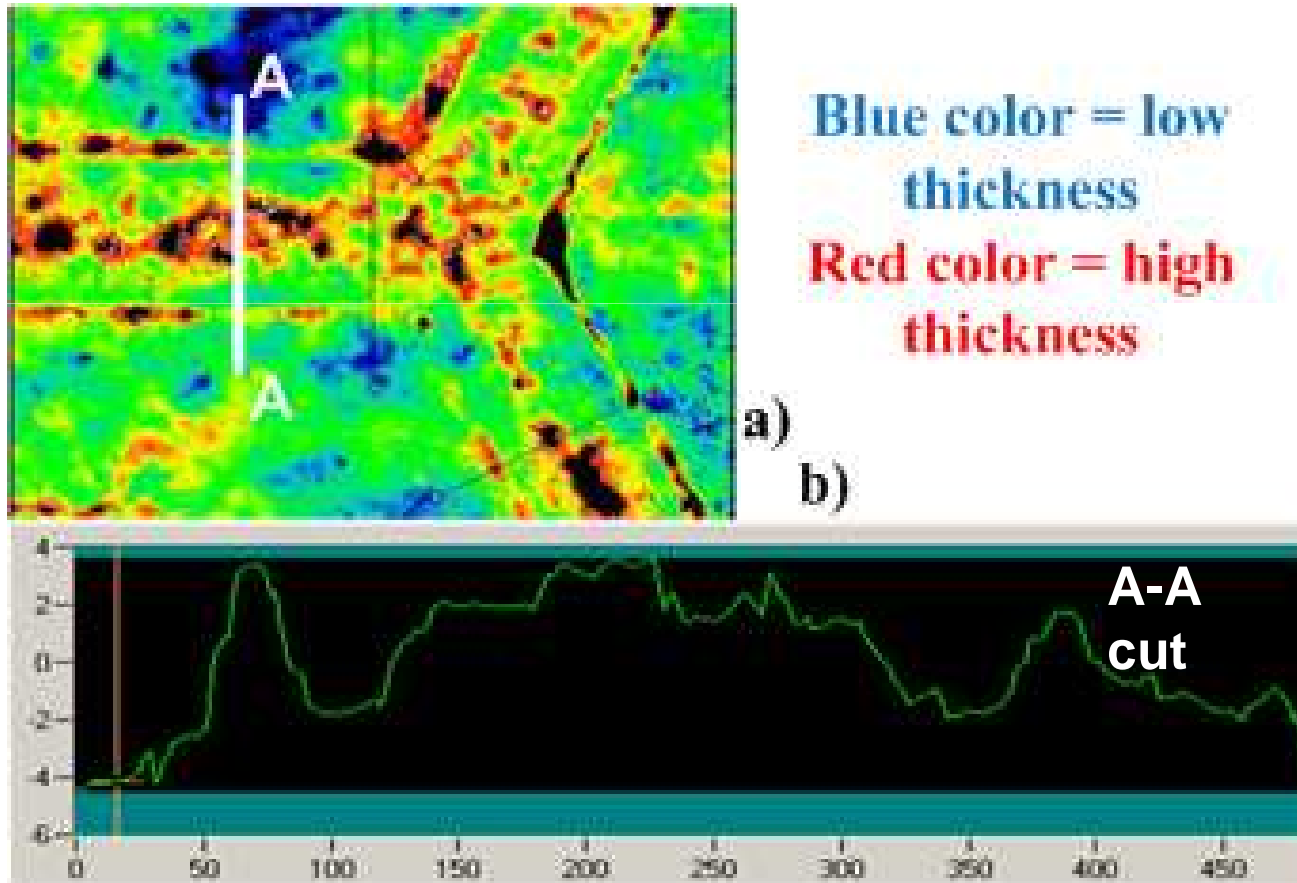
- Desired printed region width = 100µm instead of the bigger desired value
- Ink thickness in printed region = 1µm instead of 4µm in halo



Printing quality results – optimized printing



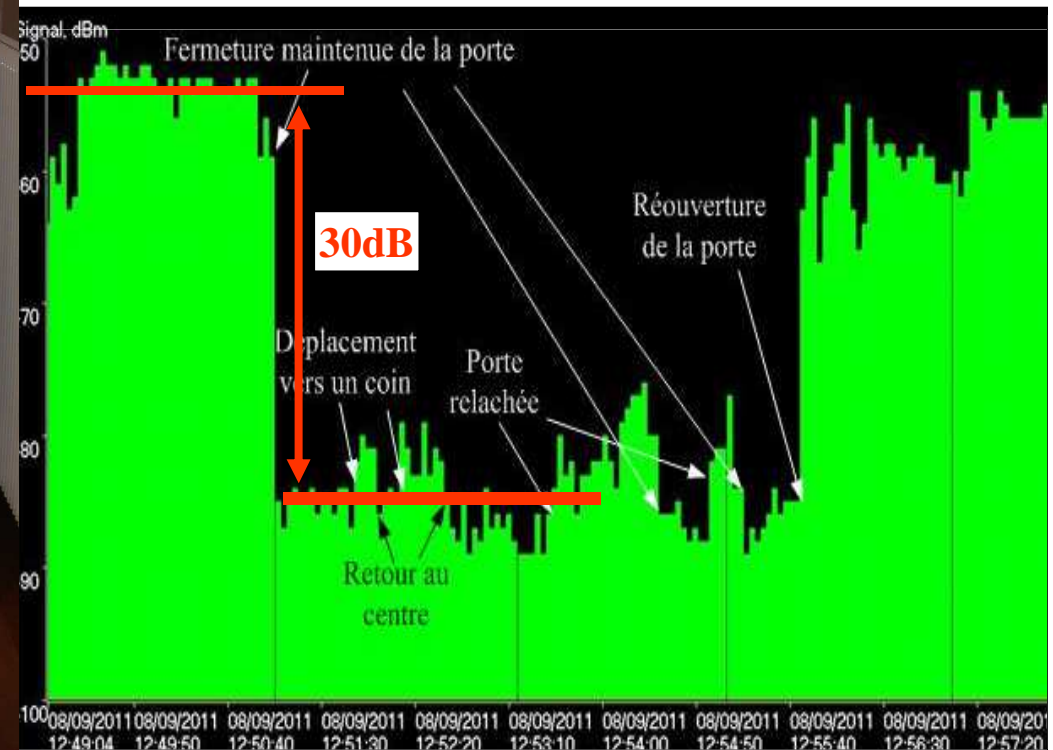
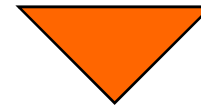
After optimization (Higher pressure smaller anilox) : no halo effect



On the industrial optimized printing:

- Printed line width = desired width
- Width of halo regions = 25 μ m
- 4 μ m of ink deposited in the desired line (without the invisible part of ink diffused in paper)
- No more ink in halo regions

Demonstrator





Technical conclusions

- **We have designed a printed wallpaper that attenuates electromagnetic waves of 20-25dB (more than 99% of waves arriving on MetaPaper)**
 - Applicable on plaster or wood
 - With any kind of glue
 - Must be covered with any kind of wallpaper
 - If two layers => $2 * 20\text{dB} = 40\text{dB}$ (spaced by 6mm –Plasterboard)
- **Industrial trials show**
 - A possibility to reduce cost (two times less ink)
 - A possibility to increase performance (Up to 30dB : 99.9% ?)
- **Close to a final optimized industrial production**

Environmental and societal conclusion



- **Integration into our environment of new means of protection against electromagnetic waves, low cost, easy to implement and with a green connotation ie markets :**
 - Different kind of existent markets (health, security of data, efficiency of personal network)
 - &
 - Possibility to develop new ones (help to completely stop a service like mobile phone for cinema or hospital)
 - &
 - Possibility to develop a non selective paper if it's interesting for market