

Bandgaps and Bandwidths of different soft surfaces

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CHALMERS



What we want to do????

Study the bandwidth of several soft surfaces as ground planes to reduce back radiation and compare with theoretical bandgap of such surfaces.

2

Outline

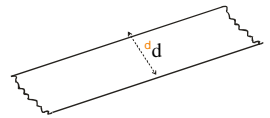
- Definition of the efficiency parameter.
- Study of back radiation as a function of the ground plane size:
 - Ideal planes (PEC, PMC) \Rightarrow Reference values
 - Corrugations (also filled with dielectric)
 - Soft surfaces (strips, strips with vias, half strips with vias)
- Bandwidth of soft surfaces: comparison with bandgaps
- Conclusions

3

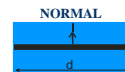
2D analysis

- With G2DMUlt results we calculate a numerical value that measures relative back radiated power

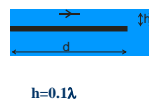
$$\Gamma_{back} = \frac{\text{power radiated for } 90^\circ < \theta < 180^\circ}{\text{total power radiated for } 0^\circ < \theta < 180^\circ}$$



Incremental sources



TRANSVERSE



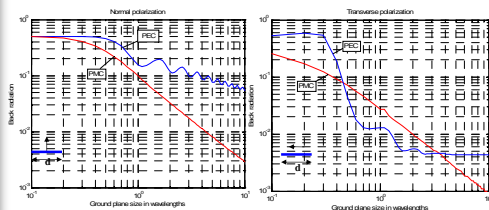
LONGITUDINAL



$$h = 0.1\lambda$$

4

Small electric sources: reference values

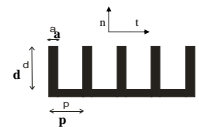


- PEC and PMC without thickness
- Incremental source
- The lines represent calculated Γ_{back}

5

SOFT SURFACES

- Most classical: corrugations
- What we expected to find for any soft surface??
- - normal and transverse like PMC (E-plane STOP)
- - longitudinal like PEC (H-plane hard GO)



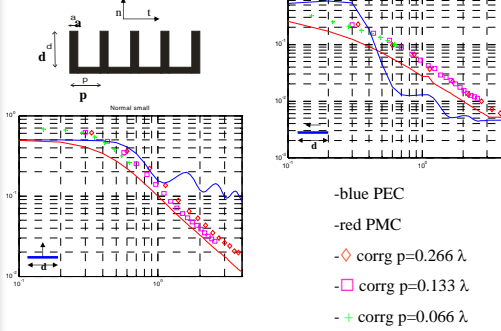
$$-d = \lambda/4$$

$$-a/p \text{ very small}$$

$$-\text{typically } p \ll \lambda/2$$

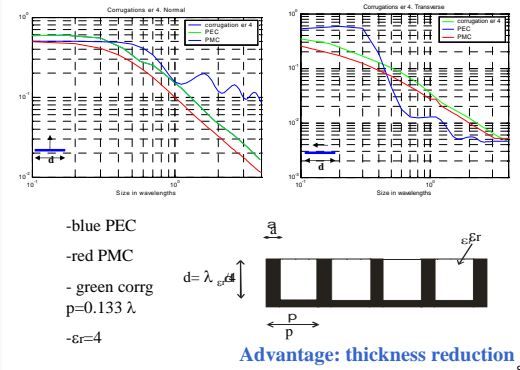
6

Classical corrugations with different periods



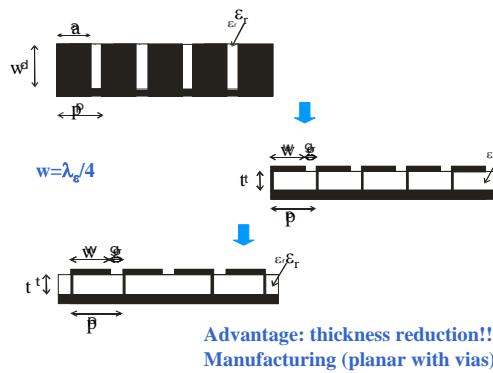
7

Dielectric-filled corrugations



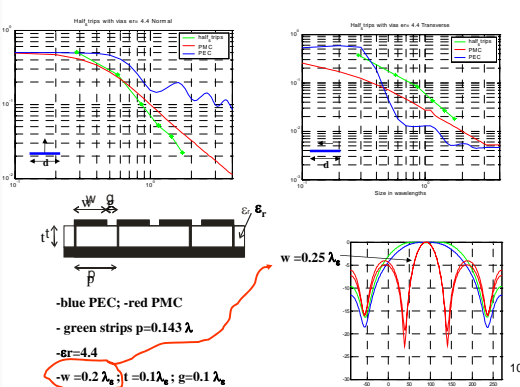
8

Planar soft surfaces



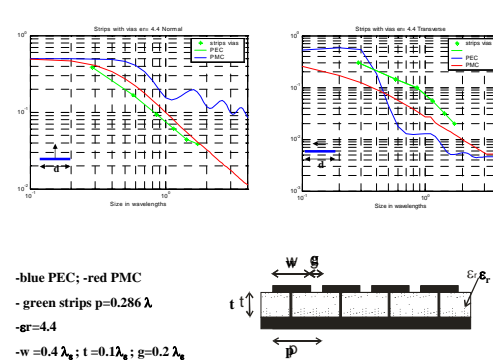
9

Half-strips with 'vias'



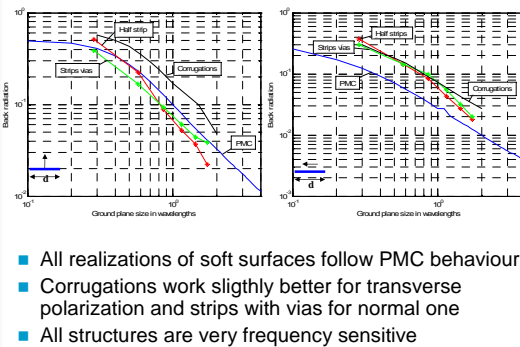
10

Strips with 'vias'



11

Summary of results and conclusions

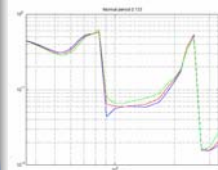


12

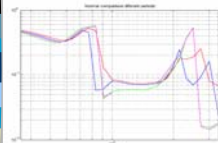
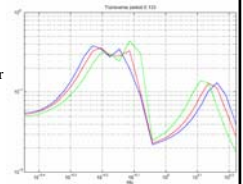
Bandwidth study

13

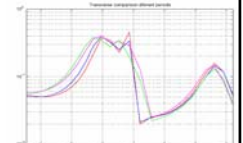
Classical corrugations



Colours for different a/p
(smallest blue line)



Colours for different period
(largest blue line)



Size $\approx 1.5\lambda$

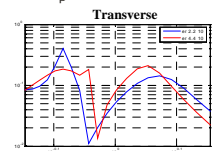
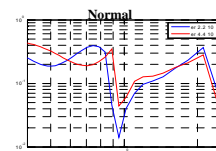
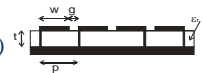
14

Classical corrugations. Some conclusions

- Normal: bandwidth does not change with a/p
- Transverse: bandwidth decreases as a/p increases $Z_s = j(p-a)/p\eta \tan(kd)$
- Both polarization have slightly larger bandwidth for larger period
- Transverse has narrower bandwidth than normal
- Expected: $d = \lambda/4$ to $d = \lambda/2$

15

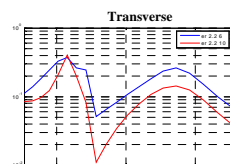
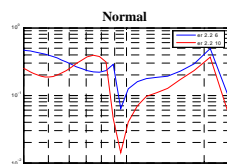
Half-strips with vias (different dielectric constants)



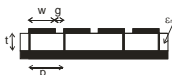
- $p = 0.095\lambda$
- $\epsilon_r = 2.2; 4.4$
- Size 1.61λ ;
 1.43λ

16

Half-strips with vias (different number of periods)

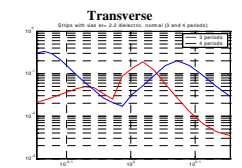
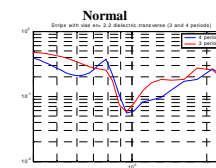


- $p = 0.202\lambda$
- $\epsilon_r = 2.2$
- Sizes 1.21λ ; 2λ



17

Strips with vias



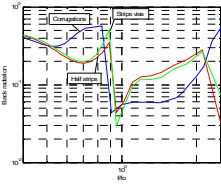
- $p = 0.4\lambda$
- $\epsilon_r = 2.2$
- Sizes 1.21λ ;
 1.6λ



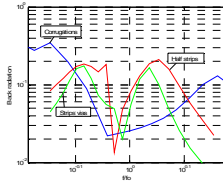
18

Comparison: corrugations and strips

Size $\approx 1.5\lambda$



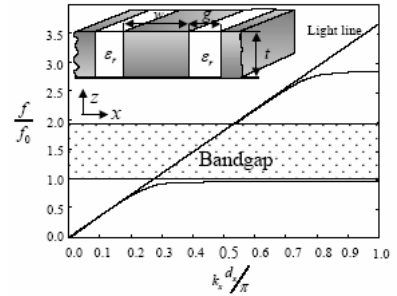
Normal



Transverse

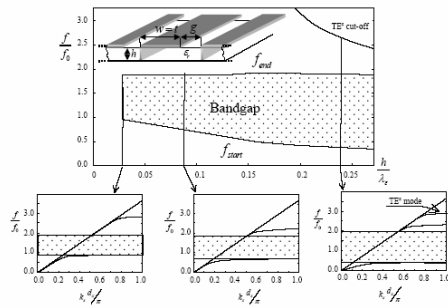
19

Theoretical bandgap: corrugations (from Marco Caiazzo's work)



20

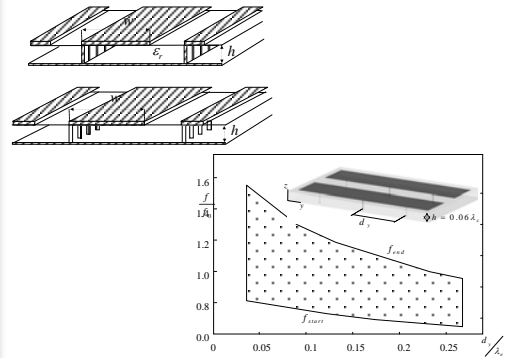
Theoretical bandgap: half strips



Larger than corrugations!!!!

21

Strip-loaded substrates with vias



22

Conclusions

- Bandgaps and bandwidths can be very different depending on particular application
- Bandwidth is larger in *classical* corrugations
- In all geometries bandwidth increases as the number of periods increases (size of ground plane)
- Bandwidth is different from bandgap of ideal 'free' structure
- All the studied geometries behave as *soft* surfaces except strips without vias
- They are useful to reduce back radiation

23

Future work

- Systematic study of bandgap dependence vs geometry parameters for planar soft surfaces
- Behavior when sources are magnetic ones
- Extension to a 3D case \Rightarrow new analysis software! \Rightarrow possibility of 'vias' study
- Change incremental source for model of a real antenna
- Manufacture, measure...

24