

European School of Antennas

PBG and EBG Background

Stefano Maci
University of Siena, Via Roma 56, I-53100 Siena, Italy

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European school of Antennas
Antenna Center of Excellence

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Opening Credits

Some transparencies have been provided by courtesy of

Dr. Daniel F. Sievenpiper
HRL Laboratories, LLC
3011 Malibu Canyon Road, Malibu, CA 90265, USA

Will McKinzie*
Etenna Corporation, 6100-C Frost Place, Laurel, MD 20707
(240) 456 – 4117, wmckinzie@etenna.com

Background: photonic bandgap (PBG)

- Terminology coming from photonics area
- Acronym PBG is already established
- Well accepted terminology for the EM application: **EBG = Electromagnetic BandGap**

Background: photonic bandgap (PBG)

2D/1D Micro Cavity Laser

Oscar Painter
Caltech

Photonic Crystal Fiber

Philip St. John Russell
U. Bath / Crystal Fibre

Dielectric Lattice with Complete Three-Dimensional Electromagnetic Stop Band

Eli Yablonovitch
UCLA

Propagating and evanescent waves

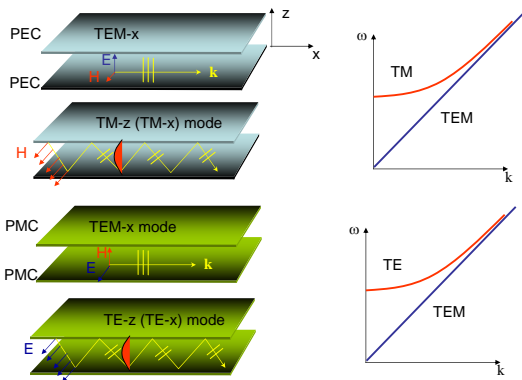
No distinction between incident and reflected waves (only one slow wave)

A particular class of EBG: artificial surface

Objectives:

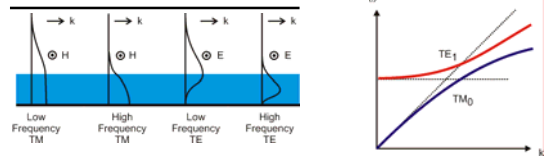
- Realizing a frequency bandwidth for which the SW is totally inhibited
- Realizing a “perfectly magnetic” equivalent ground plane (H-tangent = 0, E-tangent \neq 0)
- Realizing a “hard” surface (H-tangent \neq 0, E-tangent \leq 0)
- Realizing a “soft” surface (H-tangent = 0, E-tangent = 0)

Parallel plate waveguide propagation

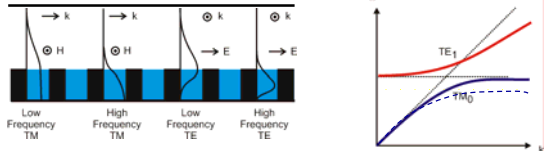


Surface waves on coated or corrugated Metal Surfaces

Parallel-plate with a dielectric-Coated Surface



Parallel-plate with dielectric filled Corrugations

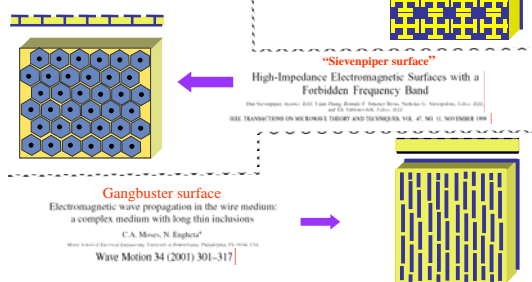


FSS used as Perfectly magnetic conductors

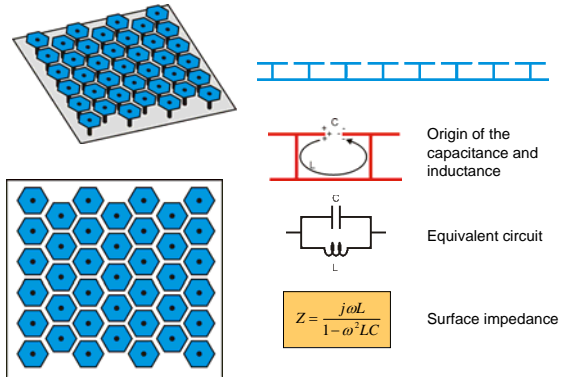
"Uniplanar compact PBG" (UP-PBG)

A Novel TEM Waveguide Using Uniplanar Compact Photonic-Bandgap (UC-PBG) Structure

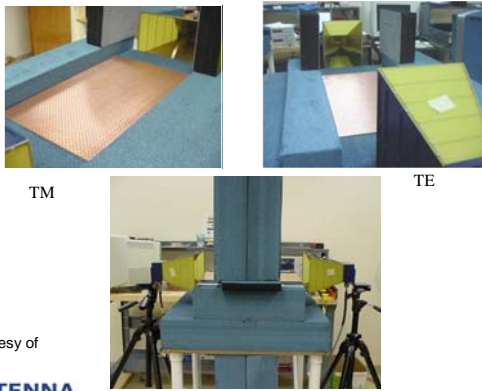
Fan-Bao Yang, Shih-Hong Wang, 2002, Kungsholmen, Sweden, 2002, 10th European Microwave Conference, 10-14 November 2002, 10-14 November 2002



Sievenpiper artificial Surfaces



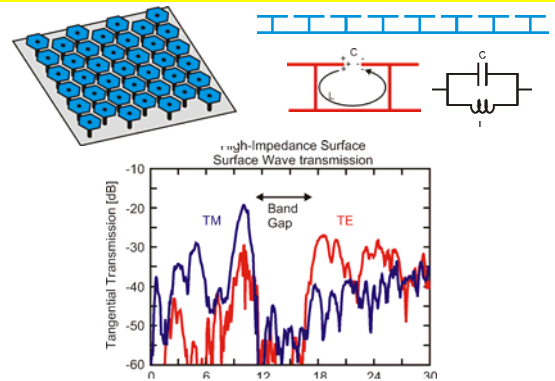
Bandgap measurements



Courtesy of

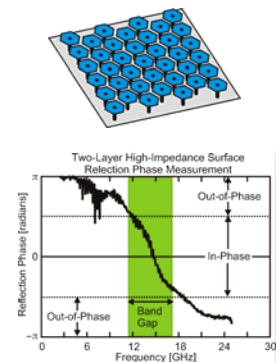
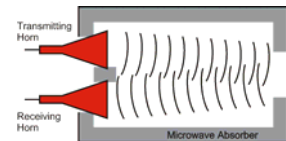


Sievenpiper surface: Bandgap measurements

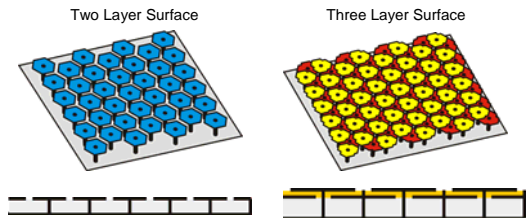


Courtesy of D. Sievenpiper - © 2003 HRL Laboratories LLC

Sievenpiper surface: reflection coefficient measurements



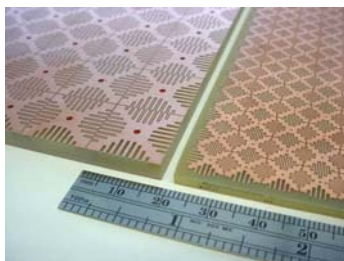
Capacitive Loading



Capacitive loading reduces the resonance frequency for a given thickness. However, the bandwidth is also reduced.

From D. Sievnpipe - © 2003 HRL Laboratories LLC

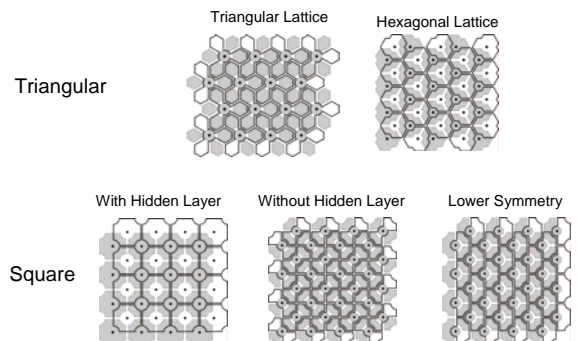
Interdigital Capacitor (ICAP) AMCs (From Mc Kenzie)



Shawn Rogers, Will McKenzie*, and Greg Mendolia
Etenna Corporation, 6100-C Frost Place, Laurel, MD 20707
(240) 456 - 4117, wmckenzie@etenna.com

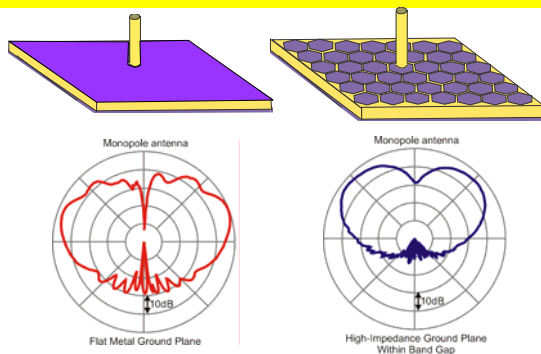


Examples of Three Layer Structures



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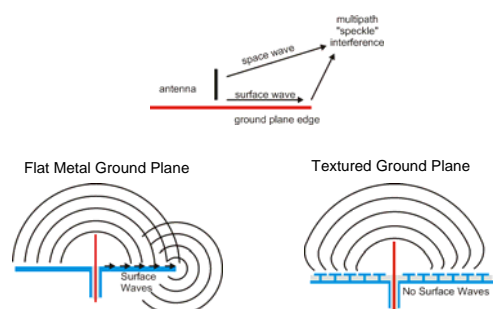
Vertical dipole



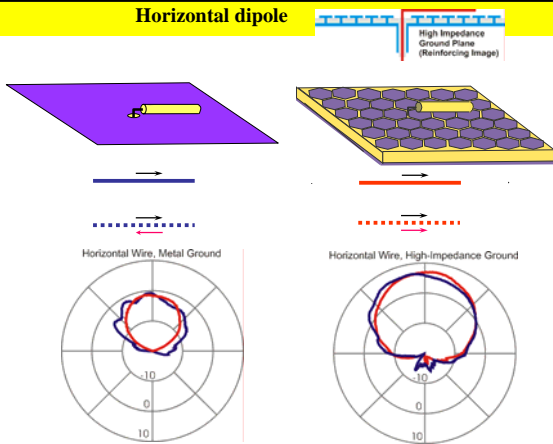
High-Impedance Electromagnetic Surfaces with a Forbidden Frequency Band

Dan Sievnpipe, Moshe, IEEE, Lijun Zhang, Ramona F. Jimenez-Salas, Nicholas G. Alexopoulos, Fellow, IEEE, and Dr. Ramon E. Williams, Jr., IEEE

Effect of Textured Surface on Radiation Patterns



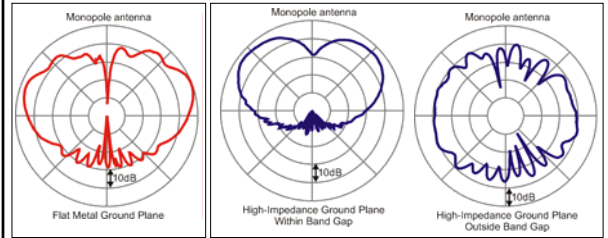
Horizontal dipole



Monopole Antenna on Flat or Textured Ground Plane

Flat Metal Ground Plane

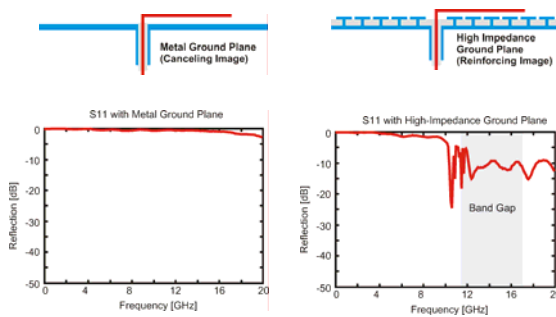
Textured Ground Plane



A textured ground plane can suppress or enhance radiation below the horizon.



Horizontal Wire on Flat or Textured Ground Plane



manufacturing (McKenzie,2001)

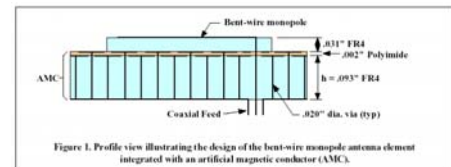


Figure 1. Profile view illustrating the design of the bent-wire monopole antenna element integrated with an artificial magnetic conductor (AMC).

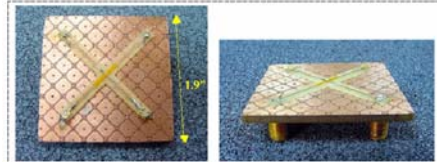
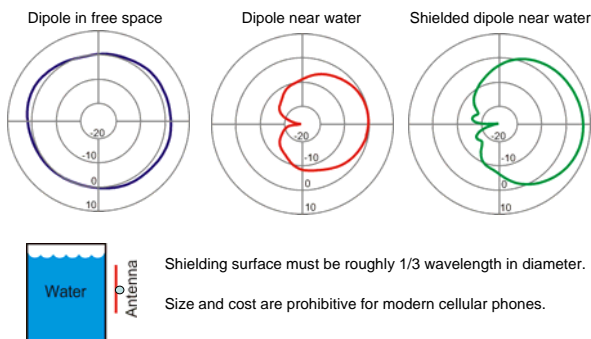


Figure 3. Top and side views of the dual linearly polarized diversity antenna

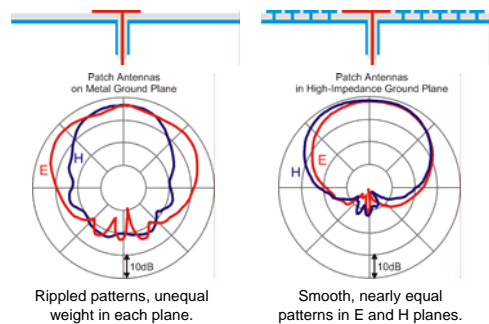
Shielding to Prevent Microwave Absorption



Shielding surface must be roughly 1/3 wavelength in diameter.
Size and cost are prohibitive for modern cellular phones.

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Patch Antenna on Flat or Textured Ground Plane

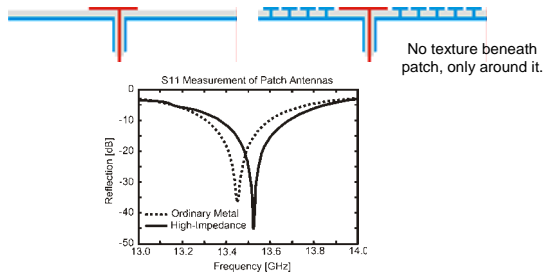


Rippled patterns, unequal weight in each plane.

Smooth, nearly equal patterns in E and H planes.

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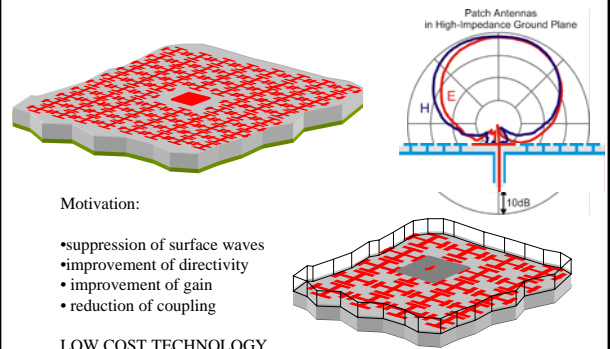
Patch Antenna on Flat or Textured Ground Plane



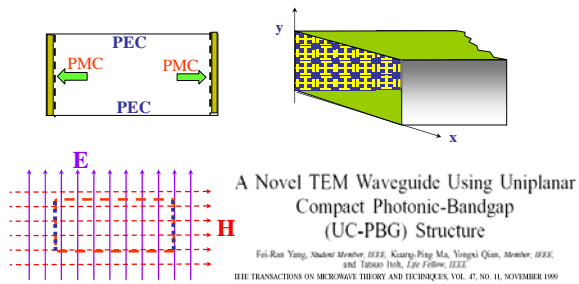
Patch resonance frequency is detuned by surface texture.

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Patch antennas on artificial periodic surfaces



Quasi TEM mode: HARD-wall waveguide



Sievenpiper surface for realizing "soft" waveguide (discussed later)