Module 1 – Introduction

Course Website:
http://emlab.utep.edu/scSVL.htm

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Short Course Outline

• Module 1 – Introduction
  – What is a spatially-variant lattice?
  – Why is it good?
• Module 2 – Spatially-Variant Planar Gratings
• Module 3 – Spatially-Variant Lattices
• Module 4 – MATLAB to CAD
Spatially-Variant Lattices

Classes of Periodic Structures

Flat
- Metasurfaces
- Frequency Selective Surfaces

Volumetric
- Metamaterials
- Photonic Crystals

Size $<< \lambda$

Size $\sim \lambda$

http://emlab.utep.edu
Electromagnetic fields and waves cannot be controlled using homogeneous materials.

There must exist some kind of inhomogeneity.

If we use metamaterials, metasurfaces, and photonic crystals as artificial materials, why are so many lattices macroscopically homogeneous?

Because it is not well known how to make them inhomogeneous without destroying their properties.

Imagine what we are missing!

Spatially Variant Lattices

What Can Be Spatially Varied?

**Period**

**Angle (°)**

**Spatially-Variant Lattice**

**Fill Factor**

**Spatially-Variant Lattice**
What Can Be Spatially Varied?

SVL Short Course

Period

Angle (°)

Spatially-Variant Lattice

Fill Factor

0.6

0.5

0.4

0.3

0.2

0

2

1.5

1

0.5

0

Spatially-Variant Lattice

0

20

40

60

80
What Can Be Spatially Varied?

Period, Angle (°), Fill Factor, Spatially-Variant Lattice

Arrays on Curved Surfaces

Periodic structures can be placed onto curved surfaces without deforming the elements or their spacing.

Arrays of Discontinuous Metallic Elements


Achievements Using Spatially-Variant Structures
Polarization Control Using Spatially-Variant Form Birefringence

Realizing Azimuthal Polarization

LP incident polarization
form-birefringent grating
azimuthal output polarization


Compensation for Surface Curvature

Spatially-Variant Self-Collimation

- Manufactured by 3D printing
- Operated at 15 GHz


World’s Tightest Unguided Bend

- Bend radius was $6.7\lambda_0$.
- Low refractive index (SU-8, $n \approx 1.59$).
- Operated at $\lambda_0 = 2.94\ \mu m$.
- Recently demonstrated $\lambda_0 = 1.55\ \mu m$


http://simlab.utep.edu
Zero Mode Coupling in MM Waveguides with Sharp Bends

First-Order Mode

Second-Order Mode

Third-Order Mode


Optical High-Speed Interconnects

BGA w VCSELs

Sharp Waveguide Bends

Circuit Board

SVPC Jumper

SVPC Funnel

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UCF
Microstrip Made Immune to Metal Object in Close Proximity

Patent Pending


Two Antennas Decoupled in 3D Printed Mobile Phone

Patent Pending
Combining Spatial Transforms with Synthesis Tool (1 of 2)

Step 1 of 4: Define Spatial Transform