Dielectric Resonator-Based Left-Handed Metamaterials: Leaky-Wave Antenna

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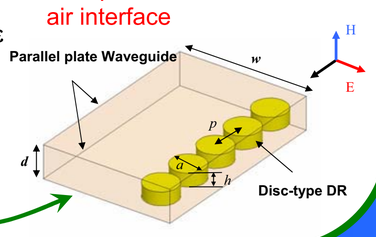
Introduction 1

Dielectric Resonator LHM Leaky-Wave Antenna

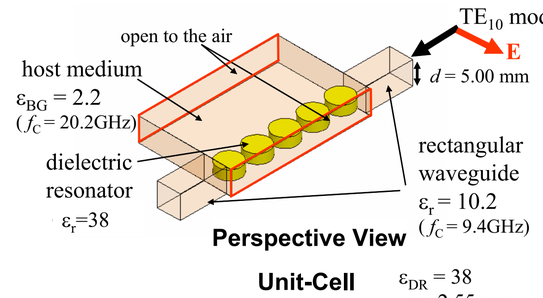
- **Properties**
  - Nonmetallic resonant structures to provide negative effective permittivity and permeability
  - Use fast-wave region for backward-scanning
- **Conventional Leaky-Wave Antenna Implementations**
  - Use higher-order mode for radiation
  - Composite right/left-handed transmission line fundamental fast-wave mode
- **Dielectric-Resonator (DR) LHM Implementation**
  - Use $TE_{01\delta}$ of DR to provide $-\mu$
  - Place DR in cutoff background which provides $-\varepsilon$

DRs placed close to air interface

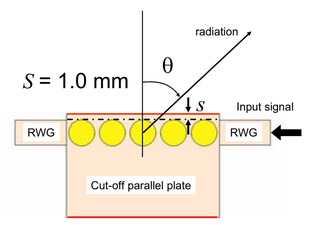
1-D LHM: cylindrical DRs in TE mode cutoff parallel plate waveguide



1-D Leaky-Wave Antenna (5-Cells) 2

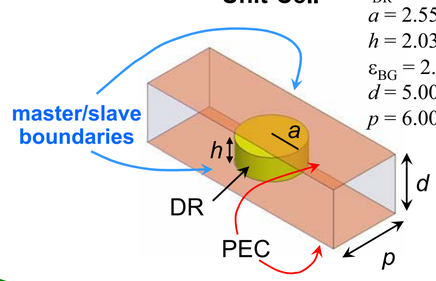


Perspective View



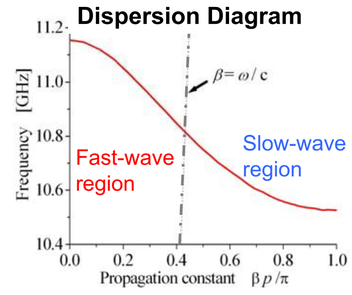
Top View

Unit-Cell



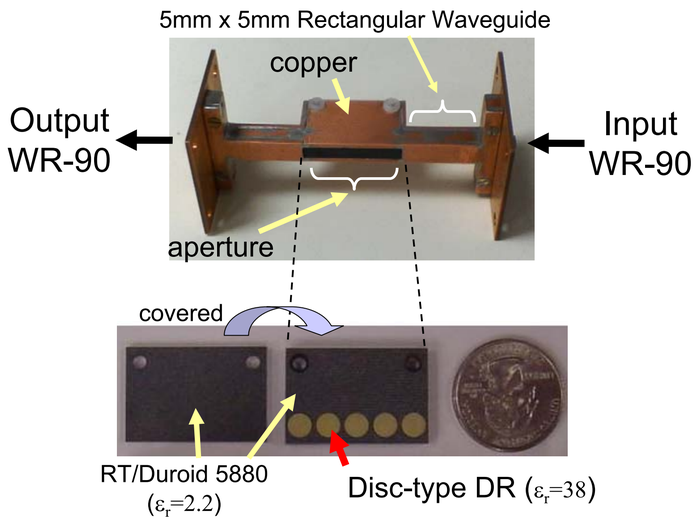
ε_{DR} = 38
a = 2.55 mm
h = 2.03 mm
ε_{BG} = 2.2
d = 5.00 mm
p = 6.00 mm

Dispersion Diagram



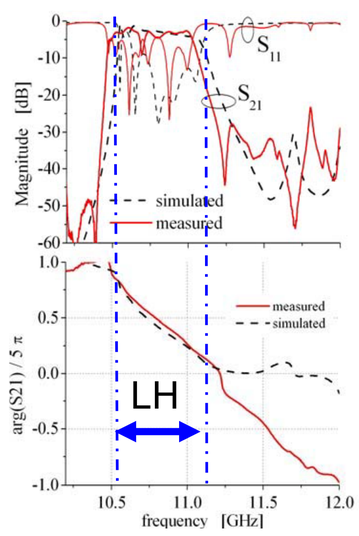
Fabricated Structure (5-Cells) 3

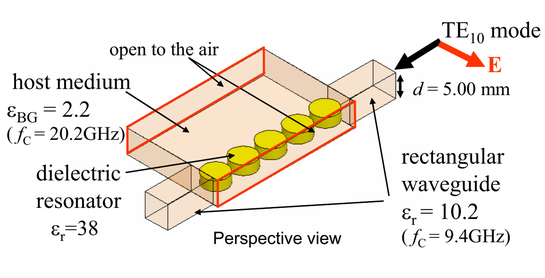
5mm x 5mm Rectangular Waveguide



Dielectric rod (RT/Duroid 6010: ε_r=10.2) inserted to feed waveguide

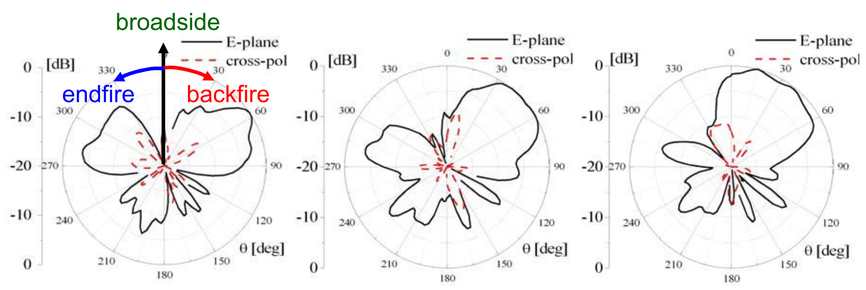
Transmission Characteristics (5-Cells) 4





Simulated Min IL = -0.7dB @10.55 GHz
Measured Min IL = -1.8dB @10.6 GHz

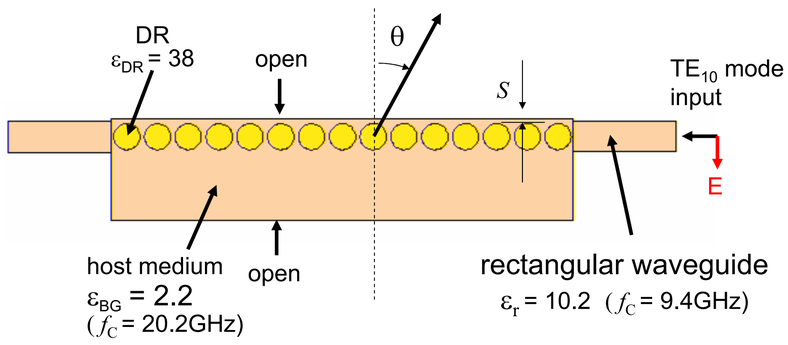
Experimental Radiation Patterns (5-Cells) 5



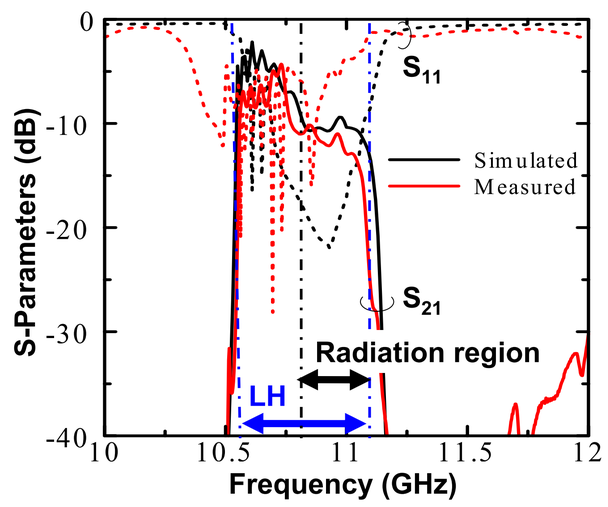
f = 10.7 GHz f = 10.9 GHz f = 11.0 GHz

- Experimental results confirm backward wave radiation.
- Increase frequency, wavelength increases.

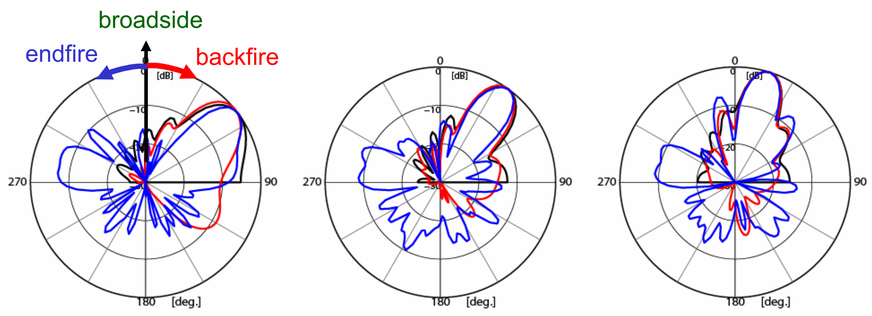
Leaky-Wave Antenna (15-Cells) 6



Transmission Characteristics (15-Cells) 7



Experimental Radiation Patterns (15-Cells) 8



f = 10.9GHz f = 11.0GHz f = 11.1GHz

Array factor using damping constant α
Full-wave analysis
Measurement