4-5-2017

Reconfigurable Antenna based on Tungsten-Doped Vanadium Dioxide Thin Films

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I. Objective
The main objective for this research is to analyze and develop tungsten-doped vanadium dioxide (WVO₂). The (.8% ratio at W) tungsten doped vanadium dioxide (WVO₂) was fabricated and measured, and the transition temperature is shifted to lower range (44°C) when the certain amount tungsten doped into the vanadium dioxide. For this research, a coplanar waveguide (CPW) bowtie patch antenna was integrated with WVO₂ thin films and the resonant frequency of the antenna can be shifted from 6.953 GHz in low temperature (20°C) to 6.358 GHz in mid temperature range (35°C) then inactive in high temperature range (50°C). The overall size of the CPW bowtie patch antenna is 6.45mm × 6mm and the substrate of the antenna is sapphire.

II. Antennas on 4” Wafer
W-VO₂ thin films were deposited on a 4” wafer with sapphire substrate for thermally controllable reconfigurable antennas. The dielectric constant of sapphire is 9.7

III. Dimensions of the Reconfigurable Antenna

Au
WVO₂
Sapphire

The layers of the thermally switchable antenna switch are Sapphire/WVO₂/Au. The substrate is sapphire, and the corresponding thicknesses are 500 μm for sapphire, 0.18 μm for WVO₂ and 0.35 μm for Au.

IV. Tungsten-Doped Vanadium Oxide

The resistivity of WVO₂ is varied in different temperature ranges. The blue line was measured from 20°C to 80°C. The orange line was measured from 80°C to 20°C.

V. Measurements
At temperature 20°C, the antenna is best matched at 6.953 GHz. This point shifts to lower frequencies as temperature increased. The resonant frequency shifts from 6.953 GHz (20°C) to 6.358 GHz (35°C) leading to a 415MHz tuning of the system.

The notch point started to level off at temperature above 40°C. At this temperature range, the resistivity of WVO₂ becomes really low and getting close to conductor status.

VI. Conclusion
1. The thermally switchable antennas were simulated, fabricated and measured, and the resonant frequency of the antenna was shifted from 6.953 GHz in 20°C to 6.538 GHz in 35°C.
2. A novel compact printed antenna for reconfigurable applications was demonstrated by employing the WVO₂ in the ground plane of an antenna system. This bowtie patch antenna has a compact structure with the total size of 6.45mm × 6mm operating between 6.953 GHz to 6.358 GHz. By adjusting the temperature between 20°C and 35°C, the notch frequency of the system is reconfigured up to 400 MHz.