# Analysis and Effects of Tungsten-Doped Vanadium Dioxide Thin Films

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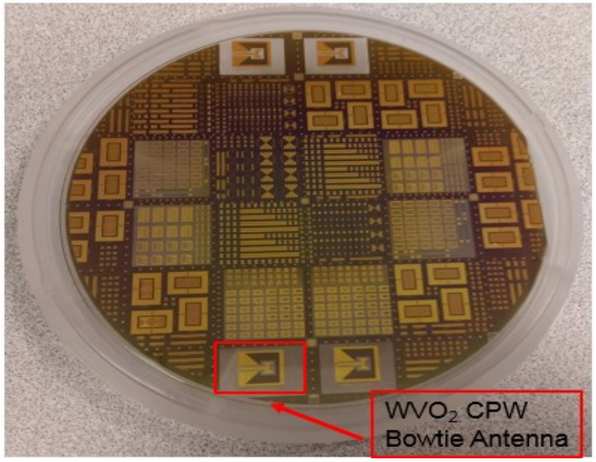
## I. Objective

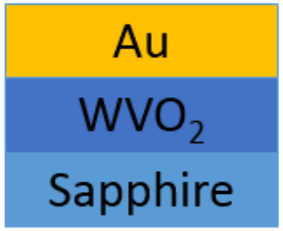
The main objective for this research is to analyze and develop tungsten-doped vanadium dioxide ($WVO_2$). The (.8% ratio at W) tungsten doped vanadium dioxide ($WVO_2$) was fabricated and measured, and the transition temperature is shifted to lower range (44°C) when the certain amount tungsten doped into the vanadium dioxide. For this research, a coplanar waveguide (CPW) bowtie patch antenna was integrated with $WVO_2$ thin films and the resonant frequency of the antenna can be shifted from 6.953 GHz in low temperature (20 °C) to 6.538 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 $6.45\text{mm} \times 6\text{mm}$ and the substrate of the antenna is sapphire.

## II. Antennas on 4" Wafer

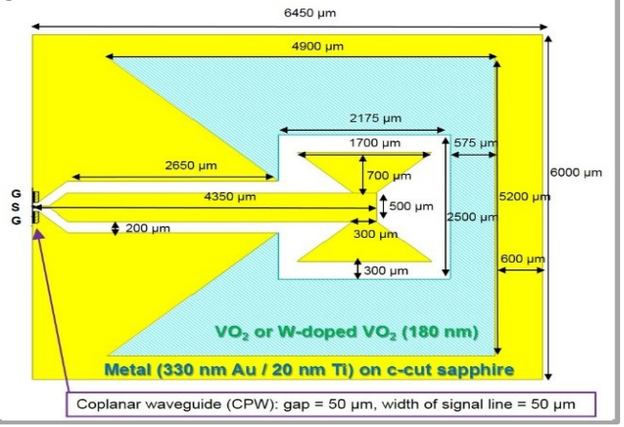
W-$VO_2$ thin films were deposited on a 4" wafer with sapphire substrate for thermally controllable reconfigurable antennas. The dielectric constant of sapphire is 9.7



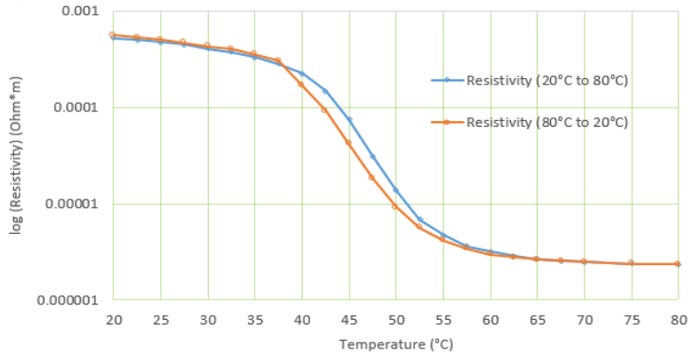

## III. Dimensions of the Reconfigurable Antenna




The layers of the thermally switchable antenna switch are Sapphire/$WVO_2$/Au. The substrate is sapphire, and the corresponding thicknesses are 500 μm for sapphire, 0.18 μm for $WVO_2$ and 0.35 μm for Au.




## IV. Tungsten-Doped Vanadium Oxide

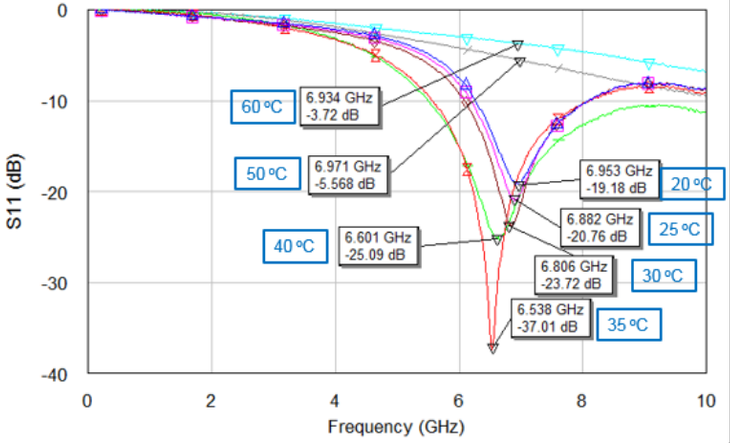



The resistivity of $WVO_2$ is varied in different temperature ranges. The blue line was measured from 20 °C to 80 °C. The orange line was measured from 80 °C to 20 °C.

## 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 6.538 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 $WVO_2$ 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 $WVO_2$ 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 6.538 GHz. By adjusting the temperature between 20°C and 35°C, the notch frequency of the system is reconfigured up to 400 MHz.