Assessment of VO_2 Phase-change Materials for Programmable Microwave Circuits

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Vanadium dioxide (VO_2) is a phase-change material that exhibits up to a four-order-of-magnitude change in electrical conductivity when it is induced thermally and optically, among other mechanisms. Therefore, VO_2 appears promising for microwave and millimeter-wave reconfigurable circuits. Current research has demonstrated low loss in thin-film VO_2 switches at microwave and millimeter-wave frequencies. In these switches, the VO_2 area is at most a few microns in length and generally thermally or electrically activated. On the other hand, an optically-induced phase change of any desired length of line could enable fully programmable distributed microwave circuits, which is extremely useful for wide-band design applications such as reconfigurable antennas and wide-band sensing. However, the quantification of RF loss of VO_2 film transmission lines and the isolation between patterned lines remains unexplored and must be addressed as the first step in determining the plausibility of this concept.

We will present our measurements of VO_2 transmission-line loss from 4-50 GHz, as well as simulations of a concept for reducing loss. This work includes the fabrication of VO_2 transmission lines, subsequent S-parameter measurements, and extraction of the attenuation coefficient. Additionally, the material parameters extracted from our measurements will assist us in accurately modeling different VO_2 structures. Because the conductivity of VO_2 in the metallic state is 10^5 S/m, we expect there to be significant loss in lines. Therefore, we will also present our simulation findings of a transmission line design that incorporates conductive patches of metal distributed within the VO_2 line in order to decrease loss while maintaining sufficient isolation between defined conductive patterns.