Reconfigurable THz Array Employing Vanadium Dioxide

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Reconfigurability has been gaining popularity for future RF, millimeter Wave and terahertz systems for sensing, imaging, wireless, and satellite communications. Indeed, significant efforts have been devoted to develop tunable systems in the past. Examples include PIN diodes, varactors and RF MEMS switches. But, in practice, these solutions have not been widely implemented due to a need for high voltage actuation, lack of integration flexibility, reliability issues, and high cost. Phase-change materials (PCMs) present an opportunity to address the shortcomings as mentioned above. Among them, vanadium dioxide (VO_2) shows insulator-to-metal transition (IMT) properties with large conductivity change on the order of ~10^4 at relatively low temperature of T_c ~68°C. This is suitable for millimeter wave and terahertz arrays since VO_2 films can be monolithically integrated onto the structures using microfabrication processes.

Various VO_2 thin film deposition techniques have been previously studied. Among them are pulsed laser deposition (PLD), sol-gel, chemical vapor deposition (CVD), atomic layer deposition (ALD), and sputtering. In our work, we have used reactive magnetron sputtering for VO_2 deposition as it provides conformal and uniform films with a relatively low-cost batch processing. Several VO_2 films, 80-nm thick were grown on *c*-plane sapphire substrates using vanadium target. By optimizing the deposition process, i.e. O_2/Ar flow ratio and deposition temperature, we tuned the electrical and phase transition properties of our film to achieve a conductivity ratio of 7×10^4. This is one of the highest ever recorded.

At the conference, we will present the fabrication and characterization of VO_2 thin films, together with examples of stopband reconfigurable arrays using VO_2. The measured responses of the arrays will also be discussed.