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Abstract

Radiofrequency commutators (RF-Switches) are key components of front-end modules. This statement is reinforced with the introduction of 5G that implies selective propagation over a growing number of communications norms. Thus, switches of various power and extended frequency ranges are needed. Silicon-On-Insulator (RF-SOI) is currently the most popular technology for front-end RF modules [1]. This is thanks to its good tradeoff in terms of ON-state resistance R_{on} and OFF-state capacitance C_{off} leading to a metric $f_c=1/(R_{on}C_{off})$ around 15 THz, breakdown voltage under high power and cost/performance ratio. Recently, Phase-Change Material technologies are emerging as a potential alternative [2-4]. These switches leverage the high electrical conductivity contrast (10^6) between the amorphous and crystalline phases of a chalcogenide material such as GeTe. Their performance could increase f_c by a factor 5 with respect to RF-SOI. They also allow integration in the Back-End of Line at low cost. However, PCM-Switches require thermal optimization which sometimes contradicts the needs of electrical design. For example, the material between the RF-PCM channel and the heater should be an electrical insulator and a thermal conductor. Other significant parameters are the thermal couplings to the substrate and to the metallic RF contacts which will drive the dynamics of the switch. In this work, we present the design and modelling of an indirectly heated switch with a GeTe channel, and a tungsten resistive heater. A dielectric material (Si_3N_4 or AlN) is used as the thermal coupler / electric insulator. We model the system with i) a lumped thermal model and ii) a Finite-Element Method software. The first method provides a quick and reasonable estimation of the response to voltages pules. The second one is more accurate and provides detailed temperature maps and heat fluxes distribution during the transient phases. Results in terms of energy efficiency and dynamics show the strong impact of: heat spreading through the RF contacts, thickness of the dielectric spacer, temperature dependence of the heater resistivity and thermal boundary resistances.

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