Silicon Carbide (SiC) Antennas for Extreme Environment Sensing Applications

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Antennas that retain their reliability and physical integrity in harsh environments (high temperature, high radiation, chemical exposure, etc.) are of great interest for military, space, and commercial applications. For instance, NASA is planning space missions to Venus which has a surface temperature around 450^{o} C. Moreover, wireless sensors used for oil drilling, aircraft propulsion and automotive engines are often exposed to high temperature, high pressure, and corrosive chemicals. To ensure efficient and reliable data transmission, antennas capable of surviving these environments have to be characterized. Silicon carbide (SiC) materials have attracted great interest recently in high temperature and high power electronics applications due to its wide energy band-gap, high thermal conductivity, excellent physical stability, and maximum operating temperature. These advantages of SiC make it superior to other commonly used conventional semiconductor materials such as silicon (Si) and gallium arsenide (GaAs). One of the emerging applications of SiC is the design of microstrip antennas. Printed microstrip antennas can easily be integrated with other circuitry including SiC IC devices. Moreover, the dielectric properties of SiC allows for antenna miniaturization and higher antenna efficiency due to its high dielectric constant ($\varepsilon_r \cong 9.8$), low loss tangent ($tan\delta \cong 10^{-6}$), and low conductivity ($\sigma \cong 10^{-5}$ S/m) values.

In this study, the main objective is to explore the microstrip patch antenna fabrication technology utilizing semi-insulating SiC materials. Sample patch antennas will be designed operating at X, S, and C bands. Following the simulations, the designed antennas will be fabricated in a clean room environment. The antennas consist of a semi-insulating SiC dielectric medium and of conductive layers on the front and back of the SiC substrate. Upon fabrication, reflection coefficient measurements are performed for validation and are compared with the simulations. Results regarding antenna parameters such as return loss, radiation pattern, and efficiency are presented. The fabrication process of the antennas is also explained in detail.