Dielectric properties of brown adipose tissue (BAT) from 0.5 GHz to 50 GHz

Nikhat Nusrat[(1)], Sydney Wojcieszak[(1)], Madeline Hays[(1)], Erdem Topsakal[(1)]

(1)Department of Electrical and Computer Engineering, Virginia Commonwealth University, Richmond, Virginia, USA

The obesity rate for those aged below 20 increased by 1.3% between 2013 and 2016. More concerning, the obesity rate for adults increased by 1.9% in the same time period. According to the Centers for Disease Control and Prevention, obesity is linked to the development of heart disease, diabetes, and other chronic diseases. Additionally, bone and joint diseases are more likely to form in obese persons. Decreasing mobility caused by these diseases make it difficult to implement necessary lifestyle changes with increasing age. Because of this, there is now a need for a method to combat metabolic inefficiency to make lifestyle changes a possibility for older people. Human fat consists of white adipose tissue (WAT) and brown adipose tissue (BAT). BAT is a high metabolic tissue that is responsible for increasing body temperature and can mediate weight gain and insulin sensitivity. Adult humans have functional BAT, but there is no method for continuously acquiring BAT energy expenditure. Variation in metabolic rate can be correlated with tissue temperature variation, providing a quantitative approach for monitoring BAT activity. The tissue temperature variations can be quantified using microwave (MW) radiometry. Since the radiometer operates at microwave frequencies, measurements of the dielectric properties of BAT are of great importance.

This paper presents the characterization of relative permittivity and electrical conductivity in BAT and WAT in rodent models across the frequency range of 0.5 – 50 GHz. The variation of dielectric properties as a function of frequency is described by a Cole-Cole model. Measurements were performed *in situ, in vitro* and *post mortem* on male and female rodent models within the 2 to 6-month age range.