Microwave transmission optimization of a modern glass window

P. Ragulis, Ž. Kancleris, E. Bilotas, R. Simniškis, and M. Dagys
Microwave Laboratory of Department of Physical Technology
Centre for Physical Sciences and Technology
Vilnius, Lithuania
paulius.ragulis@ftmc.lt

Abstract**—**Modern glass windows were investigated both experimentally and theoretically to find maximum and minimum values of microwave transmission at WiFi frequencies. The possibility to optimize transmission of microwave radiation of the windows by changing only their longitudinal dimensions was investigated. Resonance phenomena has been confirmed by experimental investigations.

Keywords-microwave propagation, shielding effectiveness, Fabry-Perot resonance, modern glass windows.

I. INTRODUCTION

State of the art multiple pane windows uses high-performance heat reflective glass. This glass is usually flat sheet of soda–lime–silicate glass covered with a several layers of metal and metal oxide those form tens of nanometers thickness conductive layer. This thin and transparent to a visible light coating effectively reflects far infrared radiation. It was realized that the metal coating reflects not only infrared radiation but it also influences propagation of electromagnetic waves in microwave frequency range [1] and affects performance of mobile phones, telecommunication and Wi-Fi devices in an urban environment. One of the possible solutions to increase microwave transmission is to use frequency selective surfaces (FSS) [2]. To use FSS a part of conductive layer should be removed to form the particular geometric pattern, which acts as a band pass filter at desirable frequencies. Therefore, the realization of the FSS is rather complicated and needs additional technological equipment during the manufacture of modern window panes. Since the resonance phenomena is tightly connected with the thickness of glasses and the gap between them, here we propose to optimize transmission of microwave radiation by changing only the longitudinal parameters of modern glass windows.

II. SHIELDING EFFECTIVENESS

Measurements of reflected and transmitted waves by the metalized glass and multiple window panes have been performed in a frequency range 2.6-12.5 GHz in an anechoic chamber. Measured transmittance is expressed as a shielding effectiveness (SE):

$$SE = 10 \cdot log\left(\frac{P_t}{P_f}\right) \qquad (1)$$

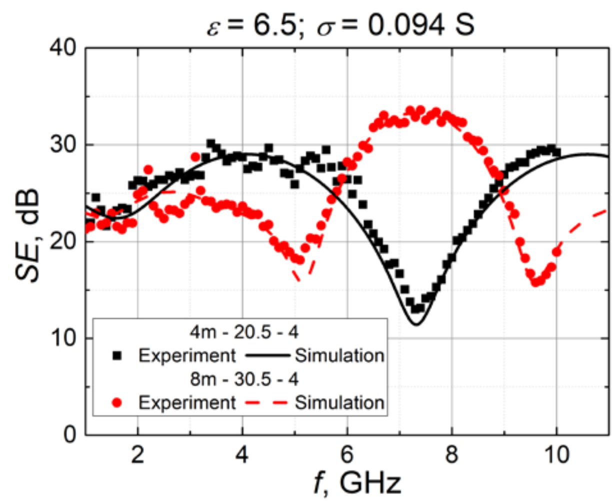

Figure 1. Shielding effectiveness of double window panes with one metalized glass, where "m" denotes metalized surface.

where P_t and P_f is the power transmitted through the window and falling on it, respectively.

Calculation results together with experimentally measured data are shown in Figure 1. Three numbers in the legend denote a thickness of the first glass, air gap and the second glass, respectively. Letter "m" denotes a surface, on which metallization is deposited, ε stands for relative dielectric constant, and σ denotes surface conductivity of the metallization. It is seen that by changing the longitudinal parameters of the window pane only, one can get the maximum and minimum shielding effectiveness at 7 GHz. The interval of the SE roughly 20 dB was measured experimentally. We formulate conditions at which maximum or minimum of the SE can be shifted to the desirable frequency.

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