Transmission and Reflection of Microwave Radiation from Novel Window Panes

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***Abstract*— Measurements of microwave reflection and transmission in a frequency range 2.6-12.5 GHz have been performed on samples of double and triple novel window panes. Thin metal layer properties were taken into account performing modeling of reflection and transmission of microwaves through the window with a help of finite-difference time-domain method.**

Keywords-microwave transmission and reflection measurements; window panes; coated window glass.

I. INTRODUCTION

Double or triple window panes are widely used in house building and restoration. They reduce heat leakage, improve acoustical isolation, control sun energy pass into a building. In recent years the coating of glass with different metal thin layers was introduced [1]. These layers usually deposited on a surface of glass using magnetron sputtering under vacuum or controlled atmosphere. The coating demonstrates low emissivity and serves, from one hand, as a reflector of far infrared radiation characteristic to the warmth appeared from the house heating. From the other hand, the layer reflects a large amount of solar energy [1]. Metallic layer deposited on the glass should influence the transmission of microwave radiation as well but we did not find the description of such investigation in the literature. It is worth to mention that the investigations presented here were motivated by the non-planed measurement of attenuation of a newly installed window in the building, which was used for onsite measurements during 7th EU framework project "HIPOW" tests in Norway in summer 2013. It was found that behind the window the microwave pulse at 5.7 GHz was attenuated by 23 dB. In this paper we present the results of more detailed investigation of reflection and transmission of microwaves through double or triple pane window samples in the frequency range 2.6-12.5 GHz. The modeling of the interaction of electromagnetic wave with window was also performed using finite-difference time-domain (FDTD) method.

II. EXPERIMENTAL SETUP AND MEASUREMENT RESULTS

Measurements of reflected and transmitted wave through the window panes have been performed in frequency range 2.6-12.5 GHz in a semi anechoic chamber. Horn antennas were used for the illumination of the sample and for the measurement of transmitted and reflected waves. Dimensions of the window samples were 20×30 cm^2. As microwave source Agilent PSG analog signal generator E8257D was used. Transmitted and reflected power was measured by Rohde & Schwarz average power sensors.

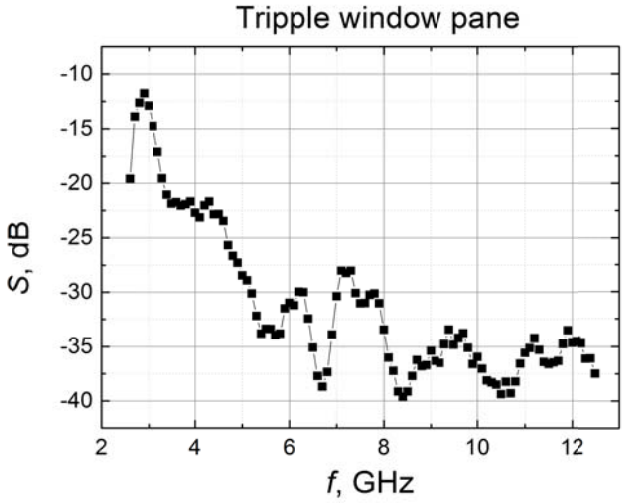

Figure 1. Dependence of microwave transmission through a triple window pane on frequency.

Typical measurement result of transmitted power through a triple window is shown in Figure 1. It is seen that attenuation of microwave signal increases with frequency reaching value of roughly -40 dB in a high frequency range. Even at a low frequency attenuation is more than 10 dB. Sufficiently large values of attenuation of microwaves by the novel window panes should be taken into account when considering a protection of infrastructure against microwave threats.

Modeling of transmission and reflection characteristics of the window panes has been performed using FDTD method. The properties of a thin metal layer deposited on the glass surface were taken into account in the modeling using method proposed in [2].

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