Shielding Effectiveness Studies of Energy Saving Windows and Coated Window Panes – a Summary

***P Ängskog*[*†], *M Bäckström*[*#], *C Samuelsson*[#], *B Vallhagen*[#]**

[*]*Electromagnetic Engineering Lab, KTH Royal Institute of Technology, Sweden, pangskog@kth.se,*
[†]*Department of Electronics, Mathematics and Natural Sciences, University of Gävle, Sweden*
[#]*SAAB Aeronautics, SAAB AB, Sweden, mats.backstrom@saabgroup.com*

Abstract—**In recent decades, window panes and windows have undergone a virtual revolution with respect to energy saving. Along with this revolution a strong reduction of radio transmission capability through windows has followed. It has been observed that radio communication (e.g. mobile telephony) in newly built or renovated buildings has become increasingly difficult to accomplish due to the higher attenuation in these energy-saving windows. On the upside though, the increased attenuation can help in the protection against intentional electromagnetic interference (IEMI) and compromising emanations from activities inside the building.**
In this paper we summarize shielding effectiveness (SE) measurements conducted on window panes and window modules during 2014 and 2015 and give some conclusions drawn regarding do's and don'ts when installing windows.

Keywords: *Shielding Effectiveness; Energy saving windows; Coated window panes; IEMI*

1 Introduction

With the purpose to determine the shielding effectiveness of energy saving windows and the window panes they are composed of, a series of measurements have been carried out at the EMC laboratory of Saab Aeronautics in Linköping, Sweden.

2 Testing

Measurements were made using two complementary methods; in a nested reverberation chamber (RC) [1] - [2], and in a semi-anechoic chamber (SAC), both covering the range 1 – 18 GHz.
A few of the window panes were also tested for HPM irradiation effects on the L-band with the field strength 28 kV/m at the Swedish MTF range in Linköping [3].

2.1 Test Methods

In the RC the sample covered an aperture in the wall of an internal nested RC, fields being stirred in both chambers.
The tests in the SAC where traditional comparative "hatch-on/hatch-off" type, carried out with a standard plane wave irradiation with normal incidence.
The HPM test was conducted as a "before/after" test where the panes were tested in the RC before and after being subject to the high-power irradiation.

2.2 Test Objects

The objects tested were four energy saving windows representing four generation of windows, and five different window panes whereof four had different coatings [4].

3 Results

An important observation among the conclusions drawn from the tests is the generation dependence of windows, where the most modern types may give an SE of on average 20 to 30 dB, potentially reaching 50 to 60 dB in the upper part of the measured frequency range while traditional two- or three-pane windows only give a few dB [4].
Other conclusions drawn are the importance of how the panes are mounted in the sashes, e.g. on which side the coating is placed, the importance of using aluminium spacerbars rather than the energy saving "warm-edge" insulating cavity spacer to avoid RF leakage.
From the HPM testing the conclusion was drawn that the type of coating determines the capability to withstand high-power irradiation without thermal break-down of the coating where soft-coated panes showed visually observable cracks while hard-coated panes survived without deterioration [3].

References

[1] M. Bäckström, T. Nilsson and B. Vallhagen, "Guideline for HPM protection and verification based on the method of power balance," in *Electromagnetic Compatibility (EMC Europe), 2014 International Symposium on*, Gothenburg, Sweden, 2014.

[2] D. A. Hill, M. T. Ma, A. R. Ondrejka, B. F. Riddle, M. L. Crawford and R. T. Johnk, "Aperture Excitation of Electrically Large, Lossy Cavities," *IEEE Trans. Electromagn. Compat.*, vol. 36, no. 3, pp. 169-178, August 1994.

[3] P. Ängskog, M. Bäckström and B. Vallhagen, "High Power Microwave Effects on Coated Window Panes," in *Asia Electromagnetics Conference (ASIAEM) 2015*, Jeju, South Korea, 2015.

[4] P. Ängskog, M. Bäckström and B. Vallhagen, "Measurement of Radio Signal Propagation through Window Panes and Energy Saving Windows," in *Proceedings of Electromagnetic Compatibility (EMC), 2015 IEEE International Symposium on*, Dresden, Germany,2015, p. 74-79.