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# WAVASORB® Microwave Absorbers

## —The Upgraded Version of ECCOSORB Microwave Absorbers

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### Abstract

Microwave Absorbers have been used to design and build Anechoic Test Facilities since a very long time. Such microwave absorbers are today available in many different shapes and dimensions, depending on the application and the frequency range. The first microwave absorbers and Anechoic Chambers have been designed and built by Emerson & Cuming starting in 1948. The well-known and famous brand name ECCOSORB has been recognized worldwide for highest quality microwave absorbers for many decades. However, due to some upcoming new international regulations related to the safety of the environment, a new series of microwave absorbers, called WAVASORB®, has been developed. These WAVASORB® absorbers are an upgraded version of our former ECCOSORB absorbers and are characterized by an excellent electromagnetic broadband performance, a fire retardancy performance compliant with the International Standards and, last but not least, by an improved environmental safety performance resulting in the fact that WAVASORB® absorbers are REACH- and RoHS-compliant.

### Keywords

absorbing materials; reflectivity; humidity-resistance; mechanical performance

### Introduction

When looking to the product ranges of the different manufacturers of microwave absorbing materials, it is obvious that different materials and technologies are used for the production of microwave absorbers. And although the use of some particular materials (polystyrene/polyethylene) and technologies (molding technology) seem to result in some advantageous properties of the microwave absorbers, E&C Anechoic Chambers have found that the best overall performance in terms of broadband reflectivity, fire retardancy, environmental safety, life time, ... is obtained using the traditional materials (carbon-impregnated flexible high-quality foam) and manufacturing techniques (impregnation and drying of pre-cut pyramidal foam elements). It is obvious that both on the level of 'materials' and on the level of 'manufacturing technique' some major improvements have been implemented over the years with the result that today a new series of microwave absorbers is available with an outstanding overall performance: WAVASORB®. In this paper the different properties of our WAVASORB® absorbers, tested partially in-house and partially by independent test laboratories, are presented in detail and some major advantages of our WAVASORB® absorbers are listed.

### Reflectivity Performance of WAVASORB® Absorbers

Although for most of the today's Anechoic Chamber applications

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(EMC, antenna testing, RCS testing, ...) the frequency range of interest is from 30 MHz to 18 GHz/40 GHz, a steadily growing demand for microwave absorbers that work properly up to 100 GHz and above is observed on the market. And because the in-house capabilities at E&C Anechoic Chambers for reflectivity testing on full-size absorbers are limited from 30 MHz to 18 GHz, a new measurement technique has been developed in cooperation with an independent test laboratory to measure the reflectivity performance of full-size absorbers up to 110 GHz. The test set-up is a double-reflector Compact Antenna Test Range and the technique is based on measuring the Radar Cross Section (RCS) of the microwave absorber. Detailed information on the test set-up and the measurement technique as well as some test results have been presented at the AMTA Node in Naples, Italy (May 23, 2016).

Broadband reflectivity measurements have been performed on both WAVASORB® VHP type absorbers (standard pyramidal foam absorbers) and on WAVASORB® VHY type absorbers (hybrid absorbers). The measured reflectivity on WAVASORB® VHP-26 absorbers and WAVASORB® VHP-26 and VHY-30 absorbers is shown in Figure 1, Figure 2 and Figure 3 respectively.

The blue curves show the measured reflectivity results while the

The blue curves show the measured reflectivity results while the red graphs show the reflectivity performances as specified in our WAVASORB® VHP Technical Bulletin.

The test results clearly show the excellent reflectivity performance of our WAVASORB® absorbers up to 110 GHz, resulting from the pyramidal design with extremely sharp tips and



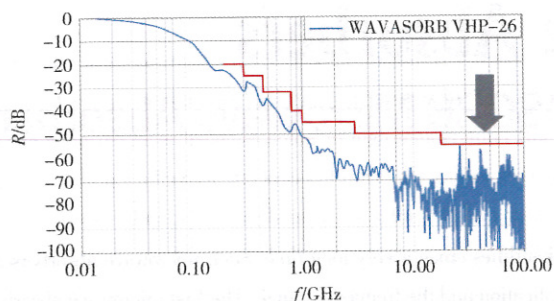


Figure 1 Reflectivity on WAVASORB® VHP-26 absorbers

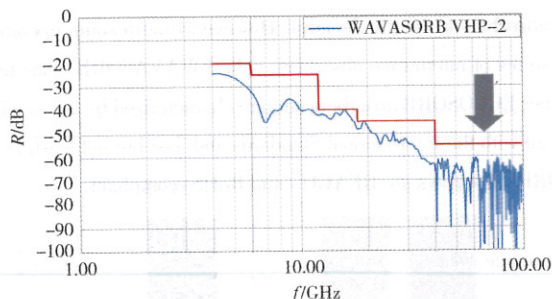


Figure 2 Reflectivity on WAVASORB® VHP-26 and VHY-30 absorbers

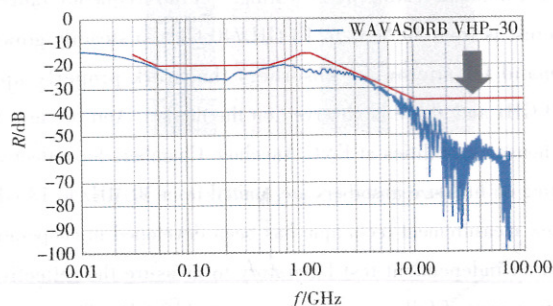


Figure 3 Reflectivity on WAVASORB® VHY-30 absorbers

valleys and from the homogeneous distribution of the carbon black inside the body of the absorbers. And due to the nature and shape of the absorbing materials, it is expected that the same outstanding reflectivity performance is reached also above 110 GHz. Some experimental work is already ongoing to prove this statement.

Because polystyrene-type absorbers are manufactured based on molding techniques, it is impossible to obtain the same level of sharpness of the tips of the pyramids with the result that the reflectivity performance at very high frequencies is worse compared to WAVASORB® absorbers.

## Fire Retardancy and Power Handling Performance of WAVASORB® Absorbers

As safety for people has the highest priority in any working environment and, accordingly, also in Anechoic Chambers, one of the major requirements for microwave absorbers is related to the fire retardancy and to the power handling capacity. And because

polyurethane foam (the basic raw material for WAVASORB® absorbers) is intrinsically a burnable material, some treatment is required for making the foam fire retardant. For a long period of time the compliance of the fire retardancy of foam absorbers with the International Standards could be achieved by using some specific chemicals which become questionable in terms of the latest REACH requirements. However, due to changing international regulations with regard to the usage of Substances of Very High Concern (SVHC list) and because those specific chemicals are on this SVHC list, E&C Anechoic Chambers decided not to use those specific chemicals.

Based on and pushed by the new regulations, a new solution has been developed for making the absorbers fire retardant. WAVASORB® absorbers do not contain any product or component which is on the SVHC list while the fire retardancy properties comply with all relevant and applicable International Standards: NRL 8093 Test 1, 2 and 3/DIN 4102 B2/EN ISO 11925-2 (2010)/ISO 4589-2 (1996) Amendment 1 (2005)/UL 94 (1991) + Revision (2009). Certificates proving the compliancy with these standards, issued by an independent test laboratory, are available for all WAVASORB® absorbers. These certificates clearly prove the high performance of WAVASORB® absorbers in terms of fire retardancy and safety.

For some other types of absorbers (polystyrene-based or polyethylene-based absorbers) the compliancy of the fire retardancy properties with the above referenced International Standards is questionable and difficult to demonstrate. Indeed, due to the nature of such absorbers they start melting already at temperatures which are far below the temperatures specified in the above referenced standards. Indeed, the NRL 8093 Test 2 is a flame test of 30 seconds and the temperature of the flame is 1900 °C. Both polystyrene and polyethylene start melting far below this temperature of 1 900 °C.

Besides the fire retardancy also the power handling capability of microwave absorbers is very important in view of the safety. Due to the open-cell structure, the power handling capacity of our WAVASORB® absorbers is proven to be better than 1.5 kW/m<sup>2</sup> for a continuous (CW) illumination with a duration of 30 minutes or less and better than 800 W/m<sup>2</sup> for a continuous (CW) illumination with a duration longer than 30 minutes. E&C Anechoic Chambers have also special-designed hollow-type absorbing materials available to be used for medium-power applications (5.0 kW/m<sup>2</sup>) and for high-power applications (15.0 kW/m<sup>2</sup>).

As opposed to foam absorbers, polystyrene-type absorbers have a completely closed structure resulting in a very slow transfer of



the generated heat from the body of the absorber to the outside. By keeping the generated heat inside the absorbers the temperature of the absorbers will raise much faster compared to foam absorbers. And accordingly the power handling capacity of polystyrene-type of absorbers is worse compared to foam absorbers.

## Environmental, Safety and Humidity-Resistance Performance of WAVASORB® Absorbers

Besides safety for people, also safety for the environment is actually a top priority topic for microwave absorbers. As already mentioned earlier in this paper the actual international regulations are high-demanding and have a very detailed list of Substances of Very High Concern (SVHClist). All series of WAVASORB® absorbers are completely free of materials and components specified in the SVHC list. Moreover all WAVASORB® absorbers are compliant with REACH- and RoHS regulations.

Regarding the resistance of WAVASORB® absorbers against humidity, it is obvious that other types of absorbers, more in particular polystyrene-type and polyethylene-type absorbers, perform better. However the performance of WAVASORB® absorbers in terms of resistance against humidity is compliant with the International Standards IEC 60068-2-78 ("Environmental testing-Part 2-78: Tests - Test Cab : Damp heat, steady state") and IEC 60068-2-1 (Test Ab: Cold test with gradual change of temperature) which means that the performance of WAVASORB® absorbers in terms of humidity resistance is also very good.

In conclusion, since the safety for people has definitely a higher priority compared to safety for the environment and humidity resistance, WAVASORB® absorbers have a much better overall performance in terms of safety and environment in comparison to polystyrene-type and polyethylene-type absorbers.

## Mechanical and Life Time Performance of WAVASORB® Absorbers

Compared to polystyrene-type absorbers which are solid, stiff and rigid, WAVASORB® absorbers are more flexible and, accordingly, they are less sensitive for damage. Due to the nature of foam and because the highest quality foam is used for manufacturing WAVASORB® absorbers, WAVASORB® absorbers are famous for their shape-memory performance. After a non-destructive deformation the absorber will always return to its original shape and dimensions without permanent damage to the absorber. As opposed

to foam absorbers, deformation of polystyrene-type absorbers will always result in permanent damage to the absorber.

Based on the highest quality of the foam used for the manufacturing, WAVASORB® absorbers have a life time of at least 20 years. Moreover, plenty of proven records (Anechoic Chambers that have been built more than 25-30 years ago and which are still having an excellent performance) are available to show that the life time can be as high as 30 years while no significant deterioration of the overall performance is observed. Such long life time proven records are hardly available for polystyrene-type and polyethylene-type absorbers.

## Conclusions

WAVASORB® microwave absorbers are the ideal solution for the design and the construction of high-performance Anechoic Chambers for different applications. Compared to polystyrene-type and polyethylene-type absorbers, WAVASORB® absorbers are recognized to be premium-quality microwave absorbers with outstanding broadband reflectivity performance and an excellent safety and environmental performance. Moreover the fire retardancy performance of WAVASORB® absorbers is compliant with the International Standards and, accordingly, can be safely used in all working places for people. And last but not least, WAVASORB® absorbers have a long life time of at least 20 years with a typical life time of 30 years.



**Jan Dauwen** is currently Sales Manager at Emerson & Cuming Anechoic Chambers. He joined Emerson & Cuming in October 1989 and has many years of experience in the design of microwave absorbing materials and anechoic chambers. Prior to his current

position of Sales Manager, Jan was working in the R&D Department at Emerson & Cuming where he was active in the development of computer software for the simulation of the performance of anechoic chambers. Jan Dauwen is a member of the Antenna Measurement Techniques Association (AMTA) and has presented a number of technical papers on different conferences all over the world.

Dr. Dauwen received his Masters degree in Physics and his Ph.D. degree in Physics (title Ph.D. dissertation: "Faraday Rotation and Optical Modulation Spectroscopy in Amorphous Hydrogenated Silicon") from The Catholic University of Leuven in Belgium in 1982 and 1989 respectively.