REFERENCES

1. Tooke L. Catherine, Hinchliffe Philip et al; β-Lactamases and β-Lactamase Inhibitors in the 21st Century; Journal of molecular biology; Volume 431, Issue 18, 23 August 2019, Pages 3472-3500
2. Mojica F. Maria, Rossi Maria-Augustina et al; The urgent need for metallo-β-lactamase inhibitors: an unattended global threat; Personal View; Volume 22, Issue 1, E28-E34, January 2022
3. Aslan, A T.; Akova, M. The Role of Colistin in the Era of New β-Lactam/β-Lactamase Inhibitor Combinations. Antibiotics 2022, 11, 277. https://doi.org/10.3390/antibiotics11020277
4. Terreni M, Taccani M, Pregnolato M. New Antibiotics for Multidrug-Resistant Bacterial Strains: Latest Research Developments and Future Perspectives. Molecules. 2021 May 2;26(9):2671. doi: 10.3390/molecules26092671.
5. Shim, H. Three Innovations of Next-Generation Antibiotics: Evolvability, Specificity, and Non-Immunogenicity. Antibiotics 2023, 12, 204. https://doi.org/10.3390/antibiotics12020204

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EXPERIMENTAL SETUP FOR THE STUDY OF LIQUID FOAMS

Many new publications in the study of the propagation of electromagnetic waves different ranges in foam structures bring a growing interest for specialists [3]. For example, S. Kharkovsky, F. Hepburn, J. Walker and R. Zoughisolved many problems with foam coatings for modern space shuttle using millimeter waves [6], V. Alekseev, O. Drobakhin and L. Filinskyy describe the possibility of using the millimeter ranges in practical study of foam for possible applications [1].

Very important problems of the technique for measuring and calculating the dielectric properties ε and tan δ in foam plastic samples located in sections of rectangular waveguides the author reviewed in [4].

V. Neagu in his work draws the readers' attention to various issues related to foam that he solved. In particular, he pays a great attention to the equipment and methods of microwave quality control of the used foam [7].

In the microwave range of 8-12 GHz, based on the experimental data were calculated value of the reflection and attenuation of electromagnetic waves in work [5].

The samples of a multilayer structure of foam model were consisted of seven layers with different dielectric characteristics. The layers were of different thickness.

"Foam caps" in work [2] have demonstrated formation of various foam structures on the surface of seas at wind speeds more than 7 meters per second.

It is very important to study the interaction of electromagnetic waves of various ranges with foam formations on the sea surface because it helps to monitor the movement of "foam caps", for weather prediction and control movement of boats, ships, submarines, which create huge traces of foam in case of their moving. These traces are well detected from aircraft and from space.

The aim of our research is to investigate the microwave propagation through the foam structures in the range from 1 to 1250 MHz of the foaming ratio 10–85 units. There are still practically no publications on this very urgent topic.

Foam is a liquid and gas mixture, water foam as usual is a static mixture of air and water. One of the main value of foam is the foaming ratio, which means the ratio volume of the mixture (foam) to the volume of foaming liquid (water).

Since the foam is constantly destroyed at a certain speed, it is necessary to measure the parameters of the foam faster than the structure of the foam changes. To do this, one must use the appropriate devices.

In our case, to study foam structures in the decimeter frequency range, a device was used to measure the frequency characteristics of coaxial devices in the range of 1-1250 MHz, on the basis of the device type R4-11, which is shown in Fig. 1.

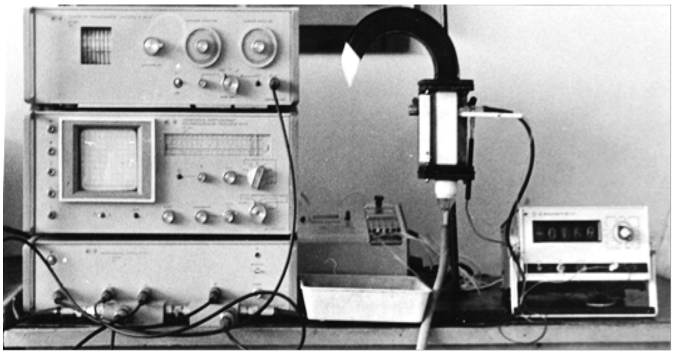

Fig. 1 – Experimental setup for the study of foams

In the operation of that device, the developers laid the principle of selecting reference and measuring signals that carry information about the parameters of the measurement object. The device for measuring reflection parameters consists of the following main parts: oscillating frequency generator, indicator block, frequency conversion unit and microwave nodes.

The operation of the device when measuring reflection parameters is carried out as follows. The microwave signal from the swept frequency generator is fed to the frequency converter unit, where it is converted into two signals shifted in frequency by 100 kHz relative to each other. One of the signals through the microwave nodes arrives at the measuring cell.

With the help of microwave nodes, signals are selected that are proportional to the voltages of the incident and reflected waves. These signals are fed to the mixers of the reference and measuring signals, where the reference signal is fed, shifted in frequency by 100 kHz.

After the mixers, signals with a frequency of 100 kHz enter the dividing circuit of the indicator unit, where the amplitude ratio is measured, and the phase difference is measured using a phase detector. After the detectors, the constant component of the voltage is fed to the screen of the cathode ray tube, where the characteristics under study are observed.

To determine the frequency at which the measured parameter is counted, a resonant frequency meter is used, which is built into the swept frequency generator, the mark of which is observed on the screen of the cathode ray tube.

When measuring the transmission parameters, in our case, attenuation, the connection scheme of the microwave nodes is modified. In this case, the output signal from the frequency converter unit is divided into two arms using a tee of reference and measuring.

In Fig. 2 is presented the strip line as the basis of the measuring cell for the study of foams, where there is an opportunity for the free movement of the foam flow.

It was designed with the main demand for distance between the bases of the strip line to be less than half of the working wavelength.

The signal from the reference arm goes directly to the frequency converter unit, and the signal in the measuring arm first passes through the measuring cell.

The further path of the signals in the frequency converter block is the same as when measuring the reflection parameters.

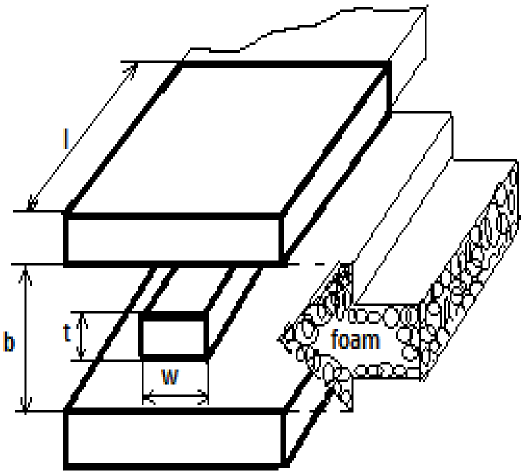

Fig. 2 – The strip line as the basis of the measuring cell for the study of foams

For the foam samples formation in the measuring cell, a foam-forming liquid is supplied inside it by the pump and at the same time air from the compressor. The air that passes through the foam generator's porous filter and foaming liquid layer forms the samples of foam structure.

The resulting foam rises through the cell, half of which goes into a channel with a strip line, and the other half passes through a transparent compartment, where its resistance was photographed and measured. The structure of the resulting foam depends on the change in the flow rate of air and foaming liquid, as well as on the porosity of the foam generator filter.

The image of a quasi-homogeneous foam sample structure is presented in Fig. 3. The diameter of inhomogeneities in the form of bulbs is in the range of 0.2–1 mm, the shape of the bulbs is spherical. This photo was taken at the initial moment after the formation of foam.

In the stationary mode, when the foam generation stops, the structure of the foam changes over time, the diameter of the bulbs increases, the neighboring bulbs combine, the thickness of the wall films decreases, the volume of the foaming liquid in the films, in the Plato-Gibs channels and the joints of the bulbs decreases.

This is due to the process of liquid outflow under the action of gravity from its upper layers to the lower layers of the foam.

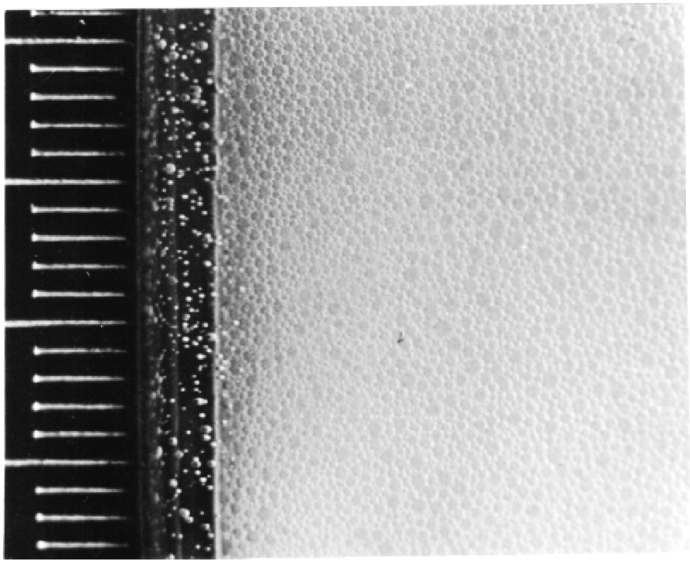

Fig. 3 – Image of the structure of a quasi-homogeneous foam sample

In fact, this is the process of destruction of the initial foam structure. From a spherical shape, the foam turns into a polyhedral one; from a quasi-homogeneous one, it takes a shape with a wider range of bulb sizes. Yes, these are no longer bulbs, but polygonal honeycombs with thin wall films, thin Plateau-Gibs channels and multifaceted nodes with a small volume of liquid.

If the outflow rate is maximum in the initial period, then the process slows down with time. The destruction process also slows down, the stability of the foam structure increases. This is the period of medium foam destruction. Further, the foam ratio increases, and over time, the foam becomes “dry” and completely disintegrates.

The study of the propagation of electromagnetic waves in such dynamic structures is rather complicated. The issues of reflection, scattering, absorption and transmission require considerable time and the development of acceptable measurement methods.

First of all calibration of the measuring setup and, in particular, the measuring cell, measurements of VSWR values in matched load mode for dry cell, distilled water as a measuring sample and foaming agent as a sample was carried out. The measuring cell was made with high quality, it is well matched over the entire operating range and has no inhomogeneities, the VSWR is somewhat greater than 1. Both water and foaming agent are similar in characteristics, at a frequency of 20, 470 and 960 MHz. They have resonances of the absorption of the reflected power on the thickness of observed samples. So the range of dielectric permittivity of samples was from 1 to 80 is almost completely available for research.

As far as lifetime of the samples was from 12 to 20 min, it was quite enough to have time to carry out VSWR measurements before the foam is significantly destroyed.

Absorption resonances of the reflected power on the thickness of the samples in the region of 330 -540 MHz were found. It was also found that when the foaming ratio of the foam increases, the resonance absorption frequency also increases. This addiction can help in determining the dielectric characteristics of the foams.

It was dependence of VSWR on foam ratio β from agent PO – 4 in short circuit mode with addition of 1%, 4% and 6% salt for ratio ranges from 10 to 15 units, from 30 to 35, and from 50 to 55 units.

The measurement data error was within 10 percent due to the constant destruction of the foam structure. Measurements can be made more accurate for foam life of more than 40 minutes and above.

As a result of the research, a symmetrical stripe cell was developed, which, in combination with a VSWR and attenuation meter, makes it possible to study the reflection characteristics of liquid foam samples with a dielectric constant in the range from 1 to 80 in the frequency range from 1 to 1250 MHz.

The measurement results show that foam structures can significantly reduce the reflections of electromagnetic waves from metal surfaces in the investigated range. So, in combination with salt additives, it is possible to achieve VSWR less than 10 in the range of 400-1250 MHz with a sample thickness of more than 4 centimeters.

REFERENCES

1. Alekseev V. V., Drobakhin O. O. and Filinskyy L. A., "Foams Absorbing Material Properties in Range of 38-52 GHz," *2006 3rd International Conference on Ultrawideband and Ultrashort Impulse Signals,* 2006, pp. 253-255, doi: 10.1109/UWBUS.2006.307220.
2. Anguelova M.D., Bettenhausen M.H., "Whitecap Fraction From Satellite Measurements: Algorithm Description," Journal of Geophysical Research: Oceans, 2019, 124(3), pp. 1827-1857.
3. Chithra A., Wilson P., Vijayan S., 2020, "Carbon foams with low thermal conductivity and high EMI shielding effectiveness from sawdust," Ind Crops Prod 145 112076, https://doi.org/10.1016/j.indcrop.2019.112076.
4. Filins'kyy L. A., "Computed dielectric properties of foam specimens measured in rectangular waveguides," Conf. Proc.2014 Int. Conf on Mathematical Methods in Electromagnetic Theory. Dnipropetrovsk, 2014. CD. pp. 152-155.
5. Filins'kyy L. A., "Modelling and calculation of reflection and transmission characteristics from water foam specimens in kind of layered structure," 2016 9th International Kharkiv Symposium on Physics and Engineering of Microwaves Millimeter and Submillimeter Waves (MSMW) 2016.
6. Kharkovsky S., Hepburn F., Walker J. and Zoughi R., "Nondestructive testing of the space shuttle external tank foam insulation using near field and focused millimeter wave techniques," Mater. Eval. vol. 63 no. 5 pp. 516-522 May 2005.
7. Neagu V., "The effects of foam on non-contacting radar-based level measurement," 2017 10th International Symposium on Advanced Topics in Electrical Engineering (ATEE). IEEE, 2017. (pp. 497-502).

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STABLE ATMOSPHERIC PLASMA OVERVIEW

Plasma stability in a gaseous environment is determined by the time during which its body is able to exist after the power source was disconnected and in the absence of strong external magnetic fields. Hence, the initiation phase, in particularly, the methods of initiation play the crucial role in the process. Among the existing technologies, the most popular is perhaps an electric arc, subjected to certain electromagnetic manipulations, aimed at creating favorable magneto dynamics. Other used techniques are foil explosion, capillary plasma injection, etc. Atmospheric pressure, however, alters the experiment significantly, and few descriptions of stable plasma configurations at pressures comparable to atmospheric pressure.

The magnetic component, which causes the plasma body formation, can be either external or produced by the arc itself. An example of the latter was described