Biological Objects Parameters Meter Based on Microwave Microscope with Coaxial Resonant Sensor

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Abstract – **The possibilities to use methods and tools of the near-field microwave microscopy for studying small-dimension biological objects are analyzed. Methods for optimization of the resonant sensor structure with regard to the objects features are developed, the system of the information signals formation is proposed.**

Keywords – **resonant sensor, biological object, near-field microwave microscopy.**

I. INTRODUCTION

To carry out biological systems investigations the contactless microwave diagnostics methods are widely used, they are based on the dependence of the biological object's effective dielectric permeability on its molecular structure and also on the contents of the free and bound water.

Taking into account that biological objects and biological media samples are, as a rule, small-dimensional ones the problem arises to create methods and devices for localization of the used microwave electromagnetic fields to increase sensitivity and resolution of the measurements being carried out.

The aim of the given work is to analyze the possibilities to use the near-field microwave microscopy for investigation of the small-dimensional biological objects.

II. MAIN PART

The basis of the near-field microwave microscopy consists in the use of the microwave microprobe structures, the localized electromagnetic fields, interacting with the objects under investigation, are formed with their help [1]. The spatial resolution is defined in this case not by the microwave radiation wavelength but by the microprobe structure and can reach the desirable nano dimensional level.

As in the case with the traditional methods of contactless microwave diagnostics, the maximal measurements sensibility in the microwave microscopy is attained when using the resonant measuring transducers (RMT). Information about characteristics of the objects under investigation and their variations will be contained in the values and variations of the resonant frequency and quality factor of the transducer.

Thus, the RMT with a probe structure and the system of its quality factor and resonant frequency measurement will be the devices defining the main metrological characteristics of the transducer as a whole.

The peculiarity of the biological objects microwave diagnostics consists in great losses both in the sample and in the construction layer structure intended for this sample placement; these losses decrease the RMT quality and, as a result, the measurements sensitivity (Fig.1).

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The performed digital analysis of the electrodynamic structure shown in Fig.1 with the use of the Maxwell equations solution results with regard to the radiation losses and characteristics of the objects being investigated makes it possible to optimize the RMT design with the coaxial aperture and to choose the required relations of the construction parameters [2].

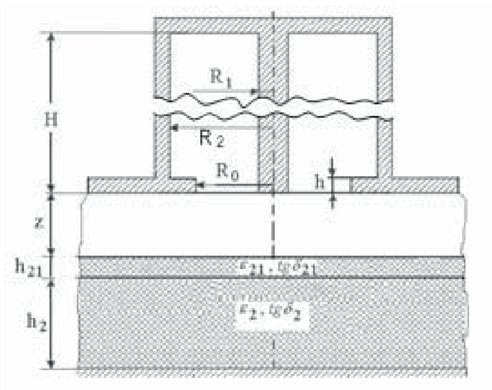

Fig.1. Resonant transducer with a coaxial aperture

The AFC system of the test microwave oscillator is used as a system for information signals formation by the resonant measuring transducer (RMT) with the microwave oscillator frequency modulation.

The signals related to $\delta f/f_0$, are singled out as an error signal after the phase detector. The signal related to $\delta Q/Q$, is singled out as a voltage on the frequency microwave detector on a frequency of 2Ω, amplified by a narrow-band amplifier and then it arrives to the processing system.

III. CONCLUSION

Methods are offered and tested for simulation of the microwave microscope with coaxial resonant sensor making it possible to optimize its structure with regard to particularities of diagnosing the biological objects, the system for the information signals' formation based on the AFC system by the resonant measuring transducer with the test FM oscillator is also offered.

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