Radiowave Methods of Non-Destructive Testing

Liske Oleksiy, Yakymiv Roman, Melnychuk Andrii

Abstract – **In this paper the analysis of existing methods of radiowave non-destructive testing which allow to detect the presence and depth of extraneous metal and dielectric defects in controlled objects is given.**

Keywords - **Non-destructive testing, artificial neural network, internal mechanical stresses, slot radiator.**

I. Introduction

Currently, the task of radiowave non-destructive testing (NDT) of industrial products and coatings of ceramics, fiberglass and numerous thin-film materials is actual. Special attention is paid to methods of detecting and registration of material anisotropy and defect detection.

II. Radiowave non-destructive testing

According to ДСТУ 2865-94 "Non-destructive testing. Terms and Definitions" [1] NDT is divided into types, i.e. the conventional methods groups, united by common physical phenomena. The classification is based on physical processes of interaction of the physical field or substance with object of non-destructive testing (ONDT).

Radiowave NDT is based on the analysis of interactions of electromagnetic radiation of radiowave range with ONDT. Usually the waves of microwave range, with length of 1-100 mm are used, and control products of materials which have low attenuation constant (dielectrics, magnetodielectrics, semiconductors and thin-walled metal objects). Methods of this type of NDT allow determine the thickness of dielectric coatings on metal substrates and detect internal metal defects [2].

Depending on the information parameter (amplitude, phase, polarization, etc.) radiowave flaw detectors are divided into the groups: amplitude, phase, amplitude-phase, geometrical and polarizing. Polarizing, in particular, are used to search for hidden defects in various materials, such as identification of anisotropy caused by presence of foreign objects and internal mechanical stresses (IMS) in dielectrics which could be caused by residual or applied stresses or texture which was obtained during the formation processes [3].

Known methods [4-6] of radiowave NDT allow to solve the problem of structurometry and defectometry, to detect the presence and depth of extraneous metal and dielectric defects in controlled objects in particular. In [7] as an antenna with low sidelobe and main radiation directed along the normal to the surface of the controlled object, which consist of two-polarization slot radiator (TPSR) is proposed. TPSR's operation with two polarizations allows not only to detect heterogeneity, but also to determine their angle.

Liske Oleksiy, Yakymiv Roman, Melnychuk Andrii - Lviv Polytechnic National University, S. Bandery Str., 12, Lviv, 79013, UKRAINE.
E-mail: roman_yakymiv@ukr.net, aliske@yandex.ru, andriimelnychuk@gmail.com.

The slot radiator's work is based on the effect of transformation of surface waves in space waves. TPSR has two resonant frequencies. The resonance frequency of the first slot is equal to 3 GHz, the resonance frequency of the second slot is equal to 3.8 GHz. These resonant frequencies are shifted to lower side with increasing thickness of controlled object. For the processing of the received signals from controlled object the artificial neural networks (ANN) is used. Using ANN allows automating the process of radiowave NDT partly excluding the impact of human factors on the identification accuracy. To improve the accuracy of measurements, during training of ANN IMS in TPSR are considered. This gives possibility to consider influence of operating conditions of TPSR in working mode.

III. Conclusion

This paper presents the results of the state analysis of current situation in radiowave NDT, existing methods that allow us to implement automated structure parameters measurement of controlled objects and detection of defects in them where reviewed. Usage of ANN in radiowave NDT in problem of defect angle measurement is perspective and not fully researched.

References

[1] Державний стандарт України. ДСТУ 2865-94. Контроль неруйнівний. Терміни та визначення. – Київ: Держстандарт України, 1995. – 51с.

[2] В. В. Панасюк, "Механіка руйнування і міцність матеріалів: Довідн. посібник", Львів ФМІ, 2001, ст. 48.

[3] В. П. Шестопалов, "Физические основы миллиметровой и субмиллиметровой техники. Источники. Элементная база. Радиосистемы", Киев, Наукова думка, Т. 2., ст.225-226, 1985.

[4] А.с. RU2146046C1, МКИ G 01N22/02. Способ электромагнитной дефектоскопии / А. Б. Орлов, К. А, Орлов, Э. А. Лутин, Н. Н. Желяев. - №99104386/09; Заявлено 03.03.1999; Опубл. 27.02.2000. - 9с.

[5] А.с. RU2146047C1, МКИ G 01N22/02. Способ электромагнитной дефектоскопии / А. Б. Орлов, К. А, Орлов, Э. А. Лутин, Л. Э. Желяева. - №99104387/09; Заявлено 03.03.1999; Опубл. 27.02.2000. - 11с.

[6] А.с. SU1748029A1, МКИ G 01N22/02. Способ СВЧ-дефектоскопии / Н.П. Жук, Н.Н. Колчигин, О.А. Третьяков, А.Г. Яровой. - №4873848/28; Заявлено 11.10.1990; Опубл. 15.07.1992, Бюл. №26 . - 4с.

[7] Melnychuk A.O., Yakymiv R.M., Liske O.M. Object detection by precision radiowave defectoscope on the basis of slot radiator with use of artificial neural network. Proc. of International Conference on Antenna Theory and Techniques ICATT'11, Kyiv, Ukraine, September 20-23, 2011.