

## REVIEW

of the Ph.D. thesis of Dariia Oleksandrivna Herasymova “Diffraction radiation from dielectric, silver and graphene circular nanowire configurations excited by modulated electron beam”, the field of knowledge 10 — Natural Sciences, specialty 104 — Physics and Astronomy

### **Significance of the research.**

With the development of research in the field of nanotechnology, new nanomaterials and nanostructured devices have been invented and manufactured.

Materials such as fullerene, carbon nanotubes, and graphene are intensively researched in order to realize new functional electronic devices of reduced size. Since the surface of graphene is chemically inactive and has high electrical conductivity, graphene film on metal is considered a promising electrical contact material that prevents oxidation of metal in air.

The thesis of D. Gerasimova belongs to such researches. It considers interesting, albeit somewhat paradoxical, problem of scattering of electromagnetic field of an electron beam on a finite number of resonant nanowires of different nature, such as dielectric and metal wires, metal nanotubes and dielectric wires covered with graphene. Despite the incompatibility of nanowires and powerful electron beams, research has the right to exist if the beams with a weak current are considered.

Among the **new** results, it worth highlighting the detection of resonances in the scattering and absorption spectra that occur when the beam trajectory shifts from a symmetrical arrangement relative to the nanowire dimer. This effect is associated with the excitation of asymmetric modes of the nanowire dimer. It is proposed to be used to determine the deviation of the position of the beam from the symmetrical one, which is indeed possible for beams with a weak current.

In addition, the “optical theorem” known from the theory of plane wave scattering is adapted for the considered problems.

### **Critical assessment of the work:**

1) In my opinion, the thesis would benefit from cooperation with specialists in the field of vacuum electronics. In particular, this would make it possible to better formulate the practical significance of the research.

2) Spatial charge waves of the electron beam are not taken into account. Although it was not difficult to take them into account within the considered model.

3) Among the solved tasks is indicated "...mastering the use of the commercial numerical codes, necessary to confirm the theoretical results." In my opinion, this point is redundant, since "mastering" refers to educational courses or self-education.

4) It is not appropriate to use the term "machine precision". It is not achievable in the problems under consideration. In addition, the error of the models themselves makes the pursuit of machine accuracy futile.

5) There are some mistakes in English terminology. For example, instead of "frequently - dependent dielectric permittivity" the term "frequency dependent dielectric permittivity" should be used.

6) There are also some mistakes in the annotation in Ukrainian. For example, the word "даймер" in the genitive case is used in the forms "даймера" and "даймеру", while only the first form is correct.

These shortcomings do not reduce the overall positive impression of the work.

To carry out research, the candidate mastered a complex mathematical apparatus, which includes the addition theorem and the method of analytical regularization.

It is also worth noting the high level of journals in which works have been published. Two papers were published in journals with quartile Q1 and four with quartile Q2.

### **Conclusion on compliance of the thesis with the norms.**

I believe that D. Herasymova's thesis "Diffraction radiation from dielectric, silver and graphene circular nanowire configurations excited by modulated electron beam" is a completed scientific work that contains a number of new, relevant and reliable results. The thesis fully complies with the requirements of the Order of the Ministry of Education and Science of Ukraine No. 40 of 12.01.2017 "On Approval of the Requirements for Dissertations" (with subsequent amendments) and "The Procedure for Awarding the Doctor of Philosophy Degree and Revoking the Decision of the One-time Specialized Academic Council of a Higher Education Institution, Scientific Institution on Awarding degree of Doctor of Philosophy", approved by the Resolution of the Cabinet of Ministers of Ukraine No. 44 of January 12, 2022.

The mastery of rather complicated mathematical methods by the Ph.D. candidate, the consistency and comprehensiveness of the research, along with the obtained new results confirm the qualification level of D. Herasymova, sufficient for awarding him the scientific degree of Doctor of Philosophy in the field of knowledge 10 "Natural Sciences", specialty 104 "Physics and Astronomy".

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