

The referee report on the project

“Raman microspectroscopy in biomedical study (“Biophotonics”)”, 2021-2023

Project leaders: G. Arzumanyan and N. Kučerka

The project is implemented by the Sector of Raman spectroscopy, which was established as a self-acting structural unit of the Frank Laboratory of Neutron Physics (FLNP) in 2015. The present review is based on the report/questionnaire provided by the project leaders G. Arzumanyan and N. Kučerka. The project “Biophotonics” has just started in 2021, therefore, the results reported are related to previous activities of the Sector.

The experimental activities of the Sector are aimed at solving original fundamental and practical problems in the field of Raman and upconversion luminescence spectroscopies and are based on the use of the multimodal optical platform – “Confotec CARS” multi-channel 3D scanning laser microscope-spectrometer. The unique characteristics of the system were significantly extended and supplemented with new functionalities in the last three years. In particular, the system was upgraded with excitation sources and several experimental modalities such as Surface-Enhanced Raman Spectroscopy (SERS), Second-Order Nonlinear Imaging of Chiral Crystals (SONICC) and SERS with Coherent Anti-Stokes Raman Scattering (SECARS). These methods are of great importance for studies of biological samples and are complemented by several other experimental techniques such as AFM, DLS, SEM/TEM, SANS. The experimental activities of the Sector are well supported by theoretical methods such as molecular dynamics simulations (Gromacs and Amber codes) and different numerical analysis approaches. ***Thus, the Sector possesses a competitive infrastructure and has a high research potential at the world level.***

The wide international collaboration of the Sector with researchers from 11 JINR Member and Associate Member States as well as a key managerial role of both project leaders involved are highly appreciated. ***An expansion of collaboration activities beyond the Member States can be recommended in the future that will open new opportunities for the Sector and will promote its visibility.***

The productivity of the Sector in terms of scientific publications in peer-reviewed journals is 12 papers during the period of three years (2018-2020), including five papers in high-impact journals with the Impact Factor $IF > 3$. The results obtained were reported at 18 international conferences including 5 keynote/invited talks, 11 oral talks and 2 posters. ***Thus, the high quality of the Sector research activities is supported by a good record of publications and numerous presentations at international conferences.***

The Sector is strongly involved in the educational activities, taking into account that the majority of the staff members are young scientists, engineers and technicians. While no Ph.D. theses have been completed yet, five master’s theses were successfully defended during the years of 2018-2020. ***Thus, the Sector has excellent possibilities for the development of its human potential in the future.***

The project „Biophotonics“ comprises two well-defined and well-balanced parts

with fundamental and applied aspects. The basic understanding of the anomalous ratio of intensities of the antiStokes/Stokes components in the SERS spectra is one of the aims with a potential impact on the development of biosensors. The understanding of such anomalies is crucial for reproducible signal registration required for sensor implementation. ***The solution to this problem will stimulate further development of the CARS system, which is already on the way.***

The applied research activities address two important and ambitious tasks: (i) the problem of lipid-protein interactions, in particular, the use of lipodiscs in studies of the structure of membrane proteins and (ii) the search for a Raman marker for early diagnosis of NETosis. ***Both topics are of high importance for their respective fields, and the expected impact is on an excellent level.***

The requested project budget is realistic with respect to the project goals and the team involved.

To conclude, the project “Raman microspectroscopy in the biomedical study (“Biophotonics”)” can be evaluated as “Excellent”, and I would recommend its implementation in 2021–2023 with ranking A.



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