

## Investigation of Rhenium by Neutrons

Ruskov I.N.<sup>1</sup>, Kopatch Yu.N.<sup>2</sup>, Tretyakova T.Yu.<sup>2,3,4</sup>, Skoy V.R.<sup>2</sup>, Fedorov N.A.<sup>2</sup>, Grozdanov D.N.<sup>1,2</sup>, Gundorin N.A.<sup>2</sup>, Shvetsov V.N.<sup>2</sup>, Sirakov I.A.<sup>1</sup>, Jovančević N.<sup>5</sup>, Knežević D.<sup>5</sup>, Badawi M.S.<sup>8,9</sup>, Thabet A.A.<sup>10</sup>, Kumar A.<sup>7</sup>, Gandhi A.<sup>12</sup>, Sharma A.<sup>7</sup>, Dongming W.<sup>11</sup>, Hramco C.<sup>2</sup>, Borzakov S.B.<sup>2</sup>, Zinicovscaia I.<sup>2</sup>, Tzvetkova Chr.<sup>6</sup>, and TANGRA collaboration

<sup>1</sup>*Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, 72, Tsarigradsko shose Blvd., 1784 Sofia, Bulgaria, [ivan.n.ruskov@gmail.com](mailto:ivan.n.ruskov@gmail.com)*

<sup>2</sup>*Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, 6, Joliot-Curie Str., 141980 Dubna, Russian Federation, [kopatch@nf.jinr.ru](mailto:kopatch@nf.jinr.ru), [dgrozdanov@mail.ru](mailto:dgrozdanov@mail.ru)*

<sup>3</sup>*Skobeltsyn Institute of Nuclear Physics (SINP), M.V. Lomonosov Moscow State University Vorob'evy Gory, 119992, Moscow, Russian Federation, [tretyakova@srd.sinp.msu.ru](mailto:tretyakova@srd.sinp.msu.ru)*

<sup>4</sup>*Faculty of Physics, M.V. Lomonosov Moscow State University, 1, building 2, GSP-2, Leninskiye Gory, 119992, Moscow, Russian Federation, [na.fedorov@physics.msu.ru](mailto:na.fedorov@physics.msu.ru)*

<sup>5</sup>*Department of Physics, Faculty of Sciences, University of Novi Sad, 4, Trg Dositeja Obradovica, 21000 Novi Sad, Serbia, [nikola.jovancevic@df.uns.ac.rs](mailto:nikola.jovancevic@df.uns.ac.rs), [miendor@gmail.com](mailto:miendor@gmail.com)*

<sup>6</sup>*Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, 11, Acad. Georgi Bonchev Str., 1113 Sofia, Bulgaria, [hristi@svr.igic.bas.bg](mailto:hristi@svr.igic.bas.bg)*

<sup>7</sup>*Department of Physics, Banaras Hindu University, 221 005 Varanasi, India, [ajaytyagi@bhu.ac.in](mailto:ajaytyagi@bhu.ac.in), [aman.marley1314@gmail.com](mailto:aman.marley1314@gmail.com)*

<sup>8</sup>*Physics Department, Faculty of Science, Alexandria University, Alexandria, Egypt, [ms241178@hotmail.com](mailto:ms241178@hotmail.com)*

<sup>9</sup>*Faculty of Advanced Basic Sciences, Alamein International University, Alamein City, Matrouh Governorate, Egypt*

<sup>10</sup>*Department of Biomedical Equipment Technology, Faculty of Applied Health Sciences Technology, Pharos University in Alexandria, Egypt, [abouzeid.thabet@pua.edu.eg](mailto:abouzeid.thabet@pua.edu.eg)*

<sup>11</sup>*School of Energy and Power Engineering, Xi'an Jiaotong University, Xianning Road No. 28, Shaanxi Province, 710049 Xi'an, China, [huasi\\_hu@mail.xjtu.edu.cn](mailto:huasi_hu@mail.xjtu.edu.cn)*

<sup>12</sup>*Horia Hulubei National Institute of Physics and Nuclear Engineering, 409, Atomists Street, 077125 Măgurele, Romania, [gandhiaman653@gmail.com](mailto:gandhiaman653@gmail.com)*

Modern and advanced technologies require the synthesis and use of new materials with improved and well-known properties and characteristics. In recent years, due to the unique properties of rhenium (Re) as one of the other refractory elements (Ta, Mo, W, Ti, Zr, Tc), its use worldwide has increased significantly. Rhenium is used, for example, in the aerospace industry (high-temperature W- and Mo-alloys for jet and rocket engines), the chemical industry, coating and welding, electronics, photography, nuclear medicine, etc. Rhenium is among the rarest metals on Earth and it does not occur uncombined or as a compound in a mineable mineral species. However, it is spread throughout the Earth's crust to the extent of ~0.001ppm. Production of rhenium is by extraction from the flue dusts of molybdenum smelters or by phytoextraction from soils and waters. The EXFOR experimental nuclear data library for the cross sections of (n, $\gamma$ ), (n,n'), (n,2n), (n,3n), (n,p), (n, $\alpha$ ) reactions (activation, differential, total), the energy and angular distributions of the reaction products contain not many data. Some of the included datasets significantly differ from each other, others have relatively large experimental error-bars. It is proposed to start a comprehensive study of the nuclear properties of rhenium isotopes using neutrons of various energies at the Frank Laboratory of Neutron Physics (FLNP) of the Joint Institute for Nuclear Research (JINR) in Dubna (Russia). The experimental results obtained can be used to better understand the mechanism of neutron-induced nuclear reactions, as well as for the needs of nuclear, life and environmental sciences.