Międzynarodowa Środowiskowa Szkoła Doktorska
przy Centrum Studiów Polarnych
w Uniwersytecie Śląskim w Katowicach

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Reference No: IEDS/2020/US/05

Proposal of PhD dissertation:

Charakterystics of Fe-bearing compounds of anthropogenic origin and their transformations in soils affected by industrial immissions

Leading unit: International Environmental Doctoral School associated with the Centre for Polar Studies at the University of Silesia in Katowice (IEDS) – Institute of Earth Sciences, the University of Silesia

Mode of study: full-time

Degree to be obtained: PhD in the field of natural sciences, in the discipline: Material engineering

Duration: 4 years (8 semesters), from October 2020

Language: English

Scholarship: approx. 2370 PLN monthly (1-2nd year); approx. 3650 PLN monthly (3-4th year)

Requirements and regulations: www.mssd.us.edu.pl/kandydat-mssd/
Registration online: www.irk.us.edu.pl

Conditions of recruitment:
I STAGE: Knowledge test in the field of discipline. The test is scored on points: from 0 to 10 points.
A positive result of the test is that the candidate gets a minimum of 7 points. Absence on the test disqualifies the candidate from the entire qualification procedure.

II STAGE: a) the final result of the candidate's completion of higher education (maximum 6 points, diploma grading ratio: 6.0 (excellent) - 6 points, 5.0 - 5 points, 4.5 - 4 points, 4.0 - 3 points. 3.5 - 2 points, 3.0 - 1 point), b) for candidates (students) referred to in art. 186 para. 2 of the Act - a certificate of average grade from at least three years of uniform Master's studies,

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rounded to one decimal place, according to the conversion factor: 6.0 (excellent) - 6 points; 5.0 - 5 points; 4.5 - 4 points; 4.0 - 3 points; 3.5 - 2 points; 3.0 - 1 point).

III STAGE: Interview for assessing: the candidate's intellectual level, knowledge of English, substantive level of the doctoral dissertation project, motivations and predispositions for scientific work, previous scientific achievements of the candidate (maximum 15 points).

Requirements:

1) Completed second-cycle studies (master's degree) in materials science, geophysics, physics, chemistry, environmental protection or related, from the discipline of materials engineering, Earth and environmental sciences, environmental engineering, mining and energy; fields of science: engineering and technology, exact and natural sciences.
2) Knowledge of research topics related to material engineering and environmental protection, in particular spectroscopic and magnetic as well as microscopic techniques of material characterization.
3) Knowledge of issues and statistical methods in the experimental data elaboration.
4) A good command of English enabling reading of scientific papers and preparing articles, presenting results at international conferences, and carrying out internships abroad.
5) Ability to work independently as well as a member of a research team.
6) Creativity and critical thinking skills.

Task description:

1) Performing magnetomeric measurements in the ground and in the laboratory (in cooperation).
2) Performing temperature Mössbauer measurements (in cooperation)
3) Analysis of acquired data.
4) Preparation of scientific articles and conference presentations.
5) Regular reporting the work progress.
6) Assistance in everyday scientific and didactic tasks of the "Nuclear research methods in material engineering" team, including co-care over measuring apparatus.

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Abstract

Dusts emitted by industrial plants, especially those where high-temperature processes are used and fossil fuels are burned (energy, metallurgy, coke, cement and ceramic industry), are a source of various types of substances polluting individual components of the natural environment, including iron-containing particles as well as heavy metals and polycyclic aromatic hydrocarbons. Soils in industrialized regions have been exposed for many years to the deposition of industrial dust, which accumulated in it and may pose a threat to the ecosystem even when the level of industrial immission has significantly reduced. In soils affected by industrial immissions compounds with a variable concentration of iron are acumulated. Most of them are technogenic magnetic particles that are iron minerals and whose presence in topsoil horizon can be detected by using the soil magnetometry methods, which involve measuring the magnetic susceptibility of the topsoil horizon. These particles are characterized by high magnetic susceptibility values directly proportional to their content in the tested material. They are considered heavy metal carriers, which can be e.g. adsorbed on their surfaces or incorporated into their crystal lattice. Strong correlation between the magnetic susceptibility of soils and dusts and the content of heavy metals was found. It is the reason why magnetic susceptibility measurements have been used for many years to identify sites of potential accumulation of heavy metals and Fe-bearing magnetic compounds in soil. To characterize these particles, the Mössbauer spectroscopy has not been used so far. As a method sensitive to the local environment of the Fe nuclide the Mössbauer spectroscopy can be a perfect complement to commonly used magnetic methods.

What is important, the accumulation of iron compounds observed in soils is not limited to compounds with magnetic properties. Few literature reports indicate that a wide group of accumulated compounds associated with anthropopressure are paramagnetic iron minerals. In the literature, the group of these minerals is briefly and ambiguously characterized and mainly microscopic methods are used to characterize them.

The comprehensive application of Mössbauer spectroscopy to identify Fe-bearing particles accumulated in soil will allow their complete characteristics. On the other hand, measurements as a function of temperature enable determination of the main factors affecting the transformation of iron-containing compounds of anthropogenic origin in contaminated soils.

The subject of planned research is the characterization of compounds containing iron of anthropogenic origin and an attempt to determine the dominant processes affecting the nature of their transformation.

The work will consist in performing investigations using magnetometry and Mössbauer spectroscopy, application of the results of another autors, including microscopic imaging:

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SEM, TEM, tests using XRD to detect and identify forms of Fe-bearing compounds of anthropogenic origin in soils affected by industrial immissions.

The interested person may also present their complementary proposals for solving the research problem. Modifying the research issue is not excluded when the Candidate presents a different original approach in terms of a content or methodology.

Additional information:

1) The work will be implemented under the substantive supervision of dr hab. Aneta Hanc-Kuczkowska, Institute of Materials Engineering, University of Silesia in Katowice, Research Team "Nuclear Methods in Materials Engineering", aneta.hanc@us.edu.pl and dr hab. Marzena Rachwał, Institute of Environmental Engineering, Polish Academy of Sciences, Zabrze, Departmnet of Environmental Magnetism and Reclamation
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