Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA21126

Grantee name: Milan Momcilovic

Details of the STSM

Title: Assessment of Plasma-Generated Carbon Nanoparticles for Electrochemical Catalysis and Sensing

Description of the work carried out during the STSM

During the STSM at Materia Nova (Mons, Belgium, 22 June–1 July 2026), I successfully carried out the experimental activities planned for the mobility under the supervision of the host research team. The work focused primarily on the synthesis, optimization, preliminary characterization, and initial electrochemical evaluation of plasma-generated carbon nanomaterials produced by methane and propane pyrolysis in a low-current gliding arc discharge (GAD) reactor. The activities performed during the mission were fully consistent with the approved work plan and all objectives assigned to the host institution were successfully accomplished.

The first stage of the mission involved practical training in the operation of the GAD plasma reactor and optimization of the synthesis procedure. Particular attention was devoted to understanding the influence of discharge current, methane and propane concentration, and reaction conditions on the formation of carbon nanomaterials. A series of ten samples was successfully synthesized under different experimental conditions, providing nanocarbon materials with different structural characteristics suitable for further investigation.

Preliminary structural characterization performed at the host institution confirmed previous findings that the low-current gliding arc discharge technique successfully produces carbon nanoflakes (CNFs) as the dominant carbon nanostructure. The obtained materials exhibited the expected morphology and structural features, confirming the reproducibility of the synthesis procedure and providing representative samples for subsequent electrochemical studies.

As part of the mission, an initial electrochemical evaluation of selected samples was also performed using the ferri/ferrocyanide redox probe. Among the investigated materials, the sample synthesized using 10% methane in the methane/argon gas mixture and a discharge current of 50 mA demonstrated particularly interesting electrochemical behavior. After modification of the glassy carbon electrode, this

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the Grant Holder Manager to verify the grant documents compliance and proceed with the payment.

material exhibited a slightly enhanced catalytic response toward the ferri/ferrocyanide redox couple, indicating improved electron-transfer kinetics compared to the unmodified electrode. Although these measurements represent only the preliminary stage of the electrochemical investigation, the observed behavior clearly demonstrates the potential of plasma-generated carbon nanoflakes for electrocatalytic applications and justifies further systematic investigation.

Throughout the mission, continuous discussions with the host researchers contributed to the interpretation of the obtained results and to the establishment of a common experimental strategy for correlating synthesis parameters with electrochemical performance. The visit also enabled valuable knowledge transfer regarding plasma-assisted synthesis of nanocarbon materials and strengthened the collaboration between the Belgian and Serbian research teams.

Description of the STSM main achievements and planned follow-up activities

The STSM successfully fulfilled its planned scientific and training objectives. The synthesis protocol for plasma-generated carbon nanomaterials was transferred to the applicant, and a representative series of carbon-based nanomaterials was prepared under systematically varied plasma conditions. Preliminary characterization confirmed the reproducibility of the synthesis procedure and verified the formation of carbon nanoflakes as the main product of the gliding arc discharge process.

A particularly important scientific outcome of the mission was the identification of a promising nanocarbon sample synthesized using 10% methane and a discharge current of 50 mA. Initial electrochemical measurements revealed a slightly pronounced electrocatalytic effect toward the ferri/ferrocyanide redox system after electrode modification, suggesting that optimization of plasma synthesis parameters may significantly influence the electrochemical properties of the obtained materials.

According to the original STSM work plan, the electrochemical characterization represents the second phase of the project and will continue at the applicant's home institution, the University of Niš. Over the next four to five months, the research will focus on completing the electrochemical evaluation of ten plasma-generated nanocarbon samples using cyclic voltammetry (CV), differential pulse voltammetry (DPV), and square-wave voltammetry (SWV), together with systematic investigations involving additional target analytes, including ascorbic acid, hydroquinone, metol, and/or hydrogen peroxide (for the sake of electrochemical sensing), as originally envisaged in the approved work plan. The obtained electrochemical parameters will then be correlated with their structural characteristics in order to establish reliable structure–property relationships governing their electrocatalytic performance.

The results obtained during the STSM provide a solid experimental foundation for the continuation of the project and for future joint publications between the host and home institutions. The collaboration established during the mission will continue through joint data analysis, interpretation of the electrochemical results, preparation of at least one scientific manuscript for publication during the next year, and the development of future collaborative research proposals within the framework of COST Action CA21126.