LENR- Experiment on Heterogeneous Hydrocarbon Plasma Jet Interaction with Ni-Foil-Target

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Research Article

LENR- Experiment on Heterogeneous Hydrocarbon Plasma Jet Interaction with Ni-Foil-Target

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Abstract

Heterogeneous Hydrocarbon Plasma (HHP) was used in LENR experiments in the studies [1], [2] for the first time. This HHP was created by a pulsed erosive capillary plasma generator (PG). The working erosive substance PMMA (polymethyl-methacrylate, monomer-$C_5H_8O_2$) was used in this PG. This work is a continuation of the previous ones [1], [2]. A calorimetric experiment with PG and distant Ni-foil cathode has been carried out in argon atmosphere (P_{st}~1 Bar). It was determined that HHP consists of the carbon nano-clusters and hydrogen atoms + hydrogen ions. These species are connected with dissociation of the initial PMMA. The interaction of HHP with thin Ni-foil target (width 0.1 ÷ 1 mm) has been studied in this work. HHP- jet heats, melts and evaporates this thin Ni-foil target. In a result of this interaction a small hole with diameter 1–3 mm in the Ni-foil target was burned by HHP-jet. Parameters of this hole were measured. Ni-foil weight was measured before and after the experiment also. It was revealed that the value COP was about of 5 ÷ 6 in this experiment (where COP = Q_T/Q_e, Q_T – thermal energy of heating, melting and evaporating of the Ni-foil-target, Q_e-electric energy input for HHP-jet creation). New transmuted chemical elements Li, Al, Ca,... were recorded in the HHP by the optical spectroscopy method, the EDS-method and the MS ICP method.

Keywords: LENR, heterogeneous hydrocarbon plasma, PMMA, Ni foil, transmutation

1. INTRODUCTION

The pulsed capillary erosive plasma generator (PG) used in this work was described in detail in our previous works [1], [2]. The PG consists of cathode (1), anode (2), dielectric working body (3) with a capillary discharge gap (Fig. 1). Dielectric working body was manufactured from PMMA. This working body was destructed and dissociated by plasma erosion. Hydrogen atoms (or ions) and carbon nano-clusters (final erosion products) are created by powerful pulsed electric discharge in the capillary gap. This PG was used in the gas calorimeter experiment in different tested gases [1].

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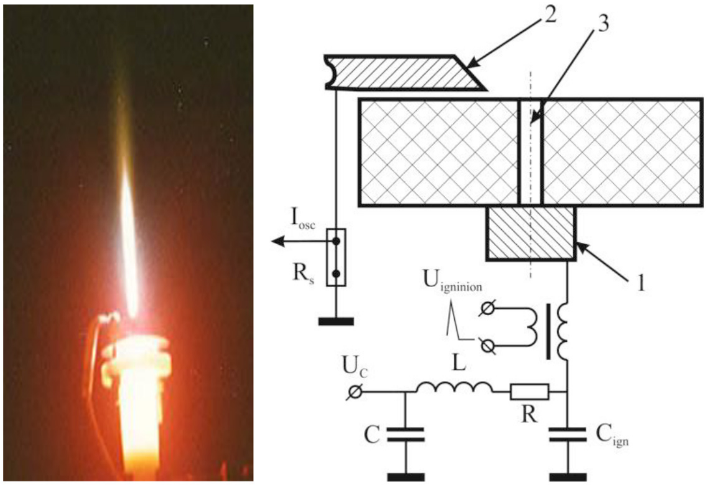

Figure 1. Electrical circuit of capillary erosive plasmotron (right). Operation regime of the PG (left). *1 – anode, 2 – cathode, 3 – capillary dielectric gap (PMMA).*

The hydrogen ion flux interacted with carbon nano-clusters and metal nano-clusters (products of electric discharge erosion) in the HHP's volume. An adiabatic gas calorimeter was used in this experiment. It was determined that the coefficient COP was about $1.4 \div 4$ in this experiment. The value COP depended on the test gas and PG's operation regime.

1.1. New Experimental Setup

The experimental setup used in this work is shown in Fig. 2. The testing section (1) $100 \times 100 \times 200$ cm was manufactured from Nylon-6. Two optical windows (2) are arranged in this section. These windows help us to obtain a high-speed video and optical spectra from HHP. These optical spectra from HHP were obtained by an optical spectrometer (AvaSpec 2048).

This section is evacuated by vacuum pump (8) and then filled by argon (7) at the initial pressure P_{st} ~0.25 – 1.5 Bar. The pulsed erosive capillary PG (3) with cathode (5) arranged inside test section (1) is used in this work. The external cathode (5) is manufactured from thin Ni- foil (width 0.1–1 mm). This Ni-target-cathode is grounded. The anode (6) is arranged behind a capillary gap of the PG (3). The anode is manufactured from nickel. Dielectric capillary gap is manufactured from PMMA. The pulsed PG creates an erosive HHP-jet (4). This heterogeneous plasma jet acts on the surface Ni-foil-target (5).

The scheme of this PG's power supply is shown in Fig. 1. The power supply (PS) has the following parameters:

Capacity storage, $C - C = 470\ \mu F$,

Filter capacity $C_{ign} - C_{ign} = 0{,}1\ \mu F$,

Ballast inductance $L - L = 17\ \mu Hn$ and $L_2 = 225\ \mu Hn$.

PS's voltage- $U_c = 600–800$ V.

Experimental conditions were the followings:

Cathode target - Ni-foil, Cu-foil, and others.

Cathode foil thickness - 0.1–1 mm.

Distance between cathode's target and PG – 5–20 mm.

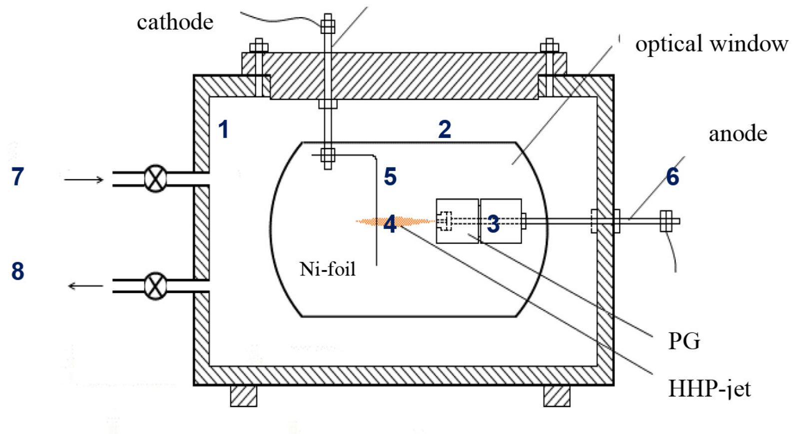

Figure 2. Schematic of experimental set up. 1- working section, 2- optical window, 3- erosive capillary plasma generator (PG), 4- HHP, 5- Ni-foil-target, 6- PG's cathode, 7- argon injection, 8- vacuum pump.

PG's capillary discharge gap:
Test substance #1 - PMMA ($C_5H_8O_2$), [H2] = 8%
Test substance #2 - C2F4, [H2] = 0%
Test substance #3 – Al_2O_3 ceramics, [H2] = 0%
Capillary diameter – 1mm, lengh-5 mm.
Test gas – Argon
Static pressure - P_{st}= 0.25–1.5 Bar.

2. MAIN EXPERIMENTAL RESULTS

1. An experimental study of interaction of a hydrogen ion flux with Ni-nano-clusters (or carbon clusters) has been carried out in argon atmosphere at the static pressure P_{st}<1.5 bar. These particles were created by an erosive PG with capillary pulsed electric discharge and Ni-foil-cathode, Fig. 1, (5). This interaction was studied by a high-speed camera. The typical high-speed video frames of interaction HHP-jet with Ni-foil-target is shown in Fig. 3. One can see that there is a hole creation in the Ni-foil-target by HHP-jet at the time delay T_d>3 ms after PG's start operation. Then HHP-jet penetrates through this foil target.
2. It was found that there is a hole in the Ni-foil-target created *by erosive plasma jet with hydrogen ions* (tested capillary substance-PMMA), Fig. 4 (left). This hole in the Ni-foil-target is absent when using of HHP-jet without hydrogen ions (tested capillary substance-C2F4 or Al_20_3 ceramics). Only a small crater in the metal target is created in this regime, Fig. 4 (right).
3. The hole's diameter and the metal weight decrease in the Ni-foil-target evaporated by HHP- jet were measured.
4. It was determined that there is a considerable extra energy release in this calorimetric experiment. The estimated value COP was about ~5 ÷ 6.

The LENR power balance was estimated by the following formulas and the following experimental results obtained in this experiment.

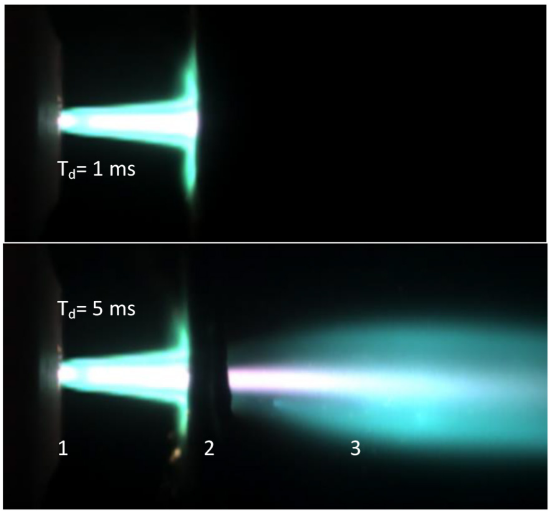

Figure 3. Interaction of a pulsed HHP-jet with the thin Ni- plate-target. T_d- delay time from PG's ignition. Hole in the Ni- target (down) with diameter 3–5 mm burned by HHP-jet. 1- PG, 2- Ni-foil-target, 3-HHP-jet. Time exposure- 0.2 μs. Frame frequency- 10 kHz.

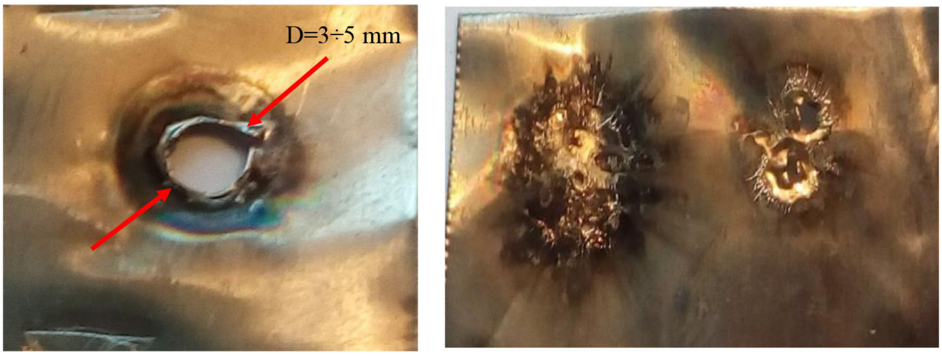

Figure 4. Interaction of a pulsed HHP-jet with the thin Ni- plate-target. Left: - small hole in the Ni- target with diameter 3–5 mm burned by HHP-jet. PMMA. Argon, $P_{st} = 0.5$ Bar. Right: - small crater in the Ni- target. C2F4. Argon, $P_{cT} = 0.5$ Bar.

- Capacity storage energy in the PG: $E_c = CU^2/2 = 85$ J.
- Pulse discharge time: $T_i \sim 10$ ms,
- Time duration of the hole's creation in Ni-foil-target: $T_{bn} \sim 3$–5 ms
- Energy input to erosive plasma (from V-Amp signals): $E_p \sim 40$ J,
- Electric energy used for hole's creation: $E_{bn} \sim 0{,}3\ E_p \sim 15$ J, at $T_{bn} \sim 3$ ms and $T_i \sim 10$ ms
- Evaporated metal mass wight drop of Ni-foil target: $\delta M_r \cong 11$ mG

One can estimate a total thermal energy Q_t considering Ni-target's heating (Q_h), melting (Q_m) and its evaporation (Q_v) by HHP-jet:

$$Qt = \Sigma Qi = Q_h + Q_m + Q_v \sim 90\text{J}$$

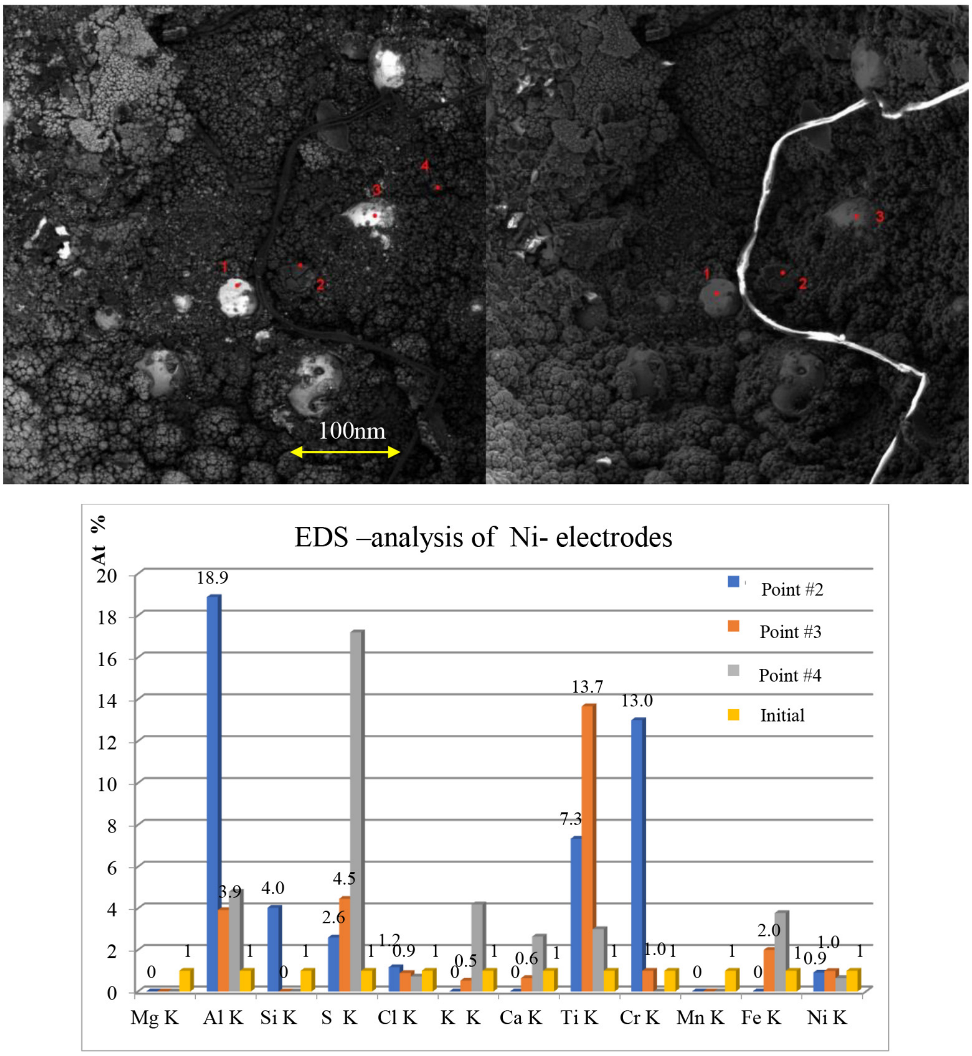

Figure 5. EDS analysis of erosive dusty particles. Photo of erosive dusty particles obtained by electron microscope (top). Relative concentrations of the new transmuted chemical elements on the dusty particle's surfaces (bottom).

So, the value COP = $Q_t/E_{bn} \sim$ **6.** Ionization energy of metal atoms and plasma radiation losses are ignored in this estimation of COP value.

A PMMA mass loss of δM_T was measured in the PG. This value was about of $\delta M_T \cong$ 0,35 mG/pulse. So, the value of maximum hydrogen atom numbers/pulse created by the PG was about of $N_H \sim 10^{19}$ atoms/pulse.

One can estimate the specific energy q of hydrogen ions with Ni-foil target interaction:

$$q = Qt/N_H \sim 100\text{eV/atom},$$

taking into account $T_{bn} \sim 0.3\ T_i \sim 10$ ms.

3. TRANSMUTATION OF INITIAL CHEMICAL ELEMENTS

The transmutation of initial chemical elements was revealed in this experiment by the EDS-method, MS ICP method and optical spectroscopy method. The typical dusty particles created on Ni-foil surface by HHP-jet are shown in Fig. 4. Relative concentrations of the new transmuted chemical elements (normalized by their initial ones) on a dusty particle's surface are shown in Fig. 5. One can see a considerable concentration jump of the new transmuted elements, such as Al, S, Ti, Fe, Cr and others. Note that pure Ni- electrodes (99.99%) are used in these experiments. These chemical elements are absent in the initial working substance PMMA. It is revealed that new transmuted elements are not stable at plasma action [5]. Optical spectra prove that new elements Al, Ca, Ti, Zn and others are created at the time period of HHP – Ni target interaction only. These elements are strong excited ones. Intensive optical lines of the Ca II, Ti II, Zn II, ... are recorded in this experiment. So, these results prove that there is real transmutation of initial chemical elements in our LENR experiment.

4. CONCLUSIONS

1. An experimental study of *hydrogen ion flux with Ni-nano-clusters (and carbon clusters) interaction* has been carried out in argon atmosphere at the static pressure $P_{st} < 1.5$ bar. These particles were created by an erosive plasma generator PG with capillary discharge and distant Ni-foil cathode.
2. Dynamics of Ni-foil-target evaporation by HHP-jet was studied by a high-speed video camera. It was revealed that there is hole creation (or crater creation) on an Ni-target surface.
3. The hole's diameter and the metal weight decrease in Ni-foil burned by HHP- jet were measured.
4. It was revealed that the burned hole in Ni-foil target is created *by erosive plasma jet with hydrogen ions* (working capillary substance-PMMA) *only*. This hole in the Ni-foil target is absent when using an erosive plasma jet without hydrogen ions (working capillary substance-C_2F_4 or Al_2O_3 ceramics).
5. It was determined that *there is a considerable extra energy release in hydrogen ion flux+ Ni nano-clusters interaction* in this work. The COP value is about ∼6 in this experiment (where COP = Q_T/Q_e, Q_T – thermal energy of heating, melting and evaporating of the Ni-foil-target, Q_e-electric energy input for HHP-jet creation).
6. *The transmutation of the initial chemical elements* is revealed in this work by EDS-method, MS-ICP method, and optical spectroscopy method.
7. The authors suppose that *LENR* is responsible for extra energy release and chemical element transmutation in this experiment.

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