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ECOSOLDER

## Romania - Republic of Serbia

### IPA Cross-border Cooperation Programme

Project: Promoting new ecologic filler alloys for soldering, based on the non-ferrous ore of the Romanian-Serbian cross-border area. Acronym Ecosolder

Project Reference: MIS ETC Code 1409

**CLOSING CONFERENCE** 21st of November 2014

**“Achievements of the ECOSOLDER Project.**

**Recommended applications for ecological filler alloys”**

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„Recommended applications  
for ecological filler alloys”



**Romania-Serbia**

Common borders. Common solutions.



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***The following applications of ecological filler alloys are presented:***

***1. Soldering applications***

***2. Brazing applications***

***3. Conclusions***

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**Romania-Serbia**

Common borders. Common solutions.

# **1. Soldering applications.**

## **Fig.1.1. Soldering terminal pads on a printed circuit board (PCB)**

- ◆ **Temperature-controlled iron soldering process**
- ◆ **Filler alloy: S-Sn90In7Ag3, elaborated in the Ecosolder project, according to EN ISO 3677 and EN ISO 9453**
- ◆ **Flux: colophon**



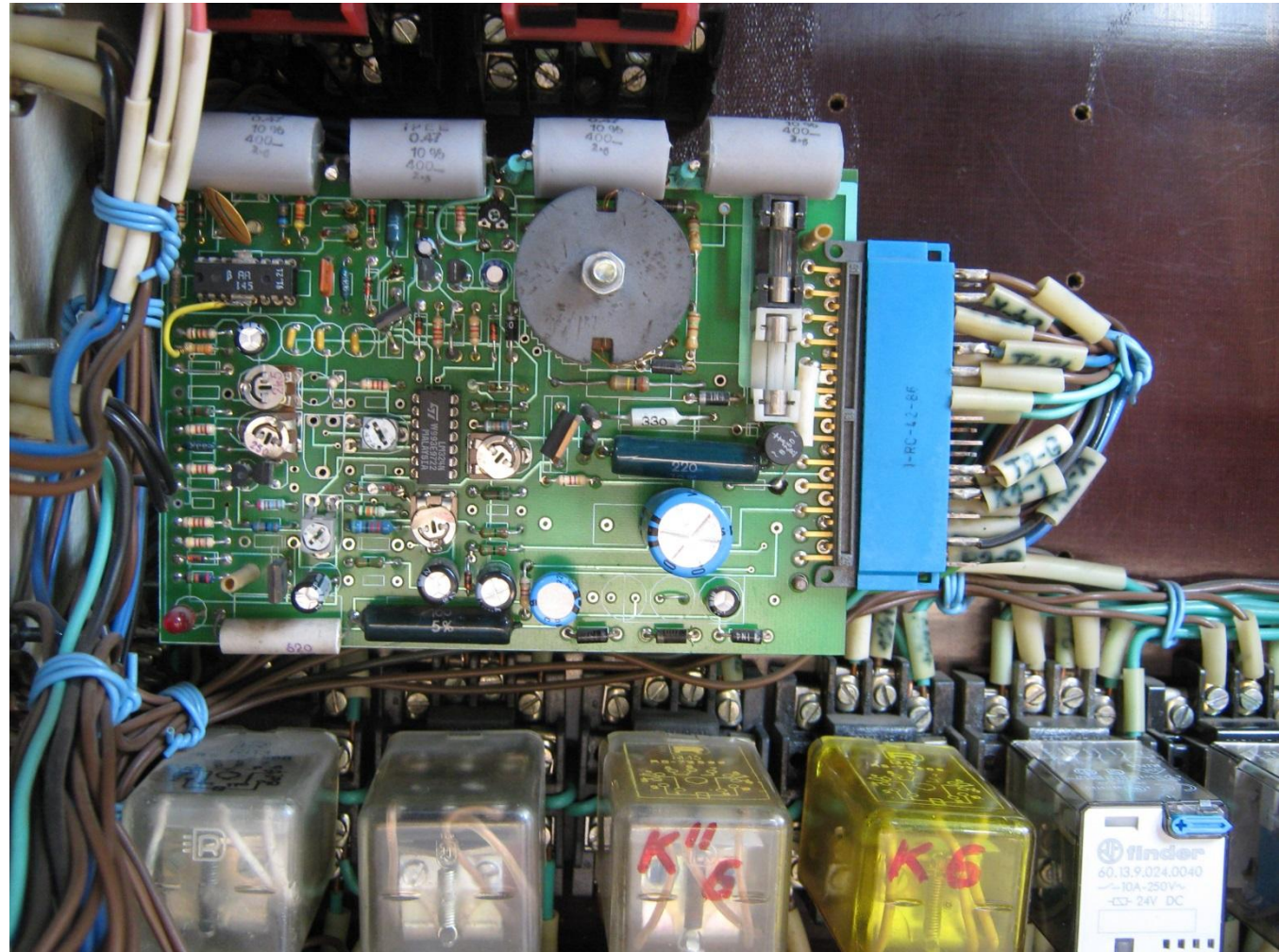
## ***Fig.1.2. Soldering terminal pads on the PCB of a voltage regulator for car battery***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn90In7Ag3, elaborated in the Ecosolder project, according to EN ISO 3697 and EN ISO 9453***
- ◆ ***Flux: colophon***



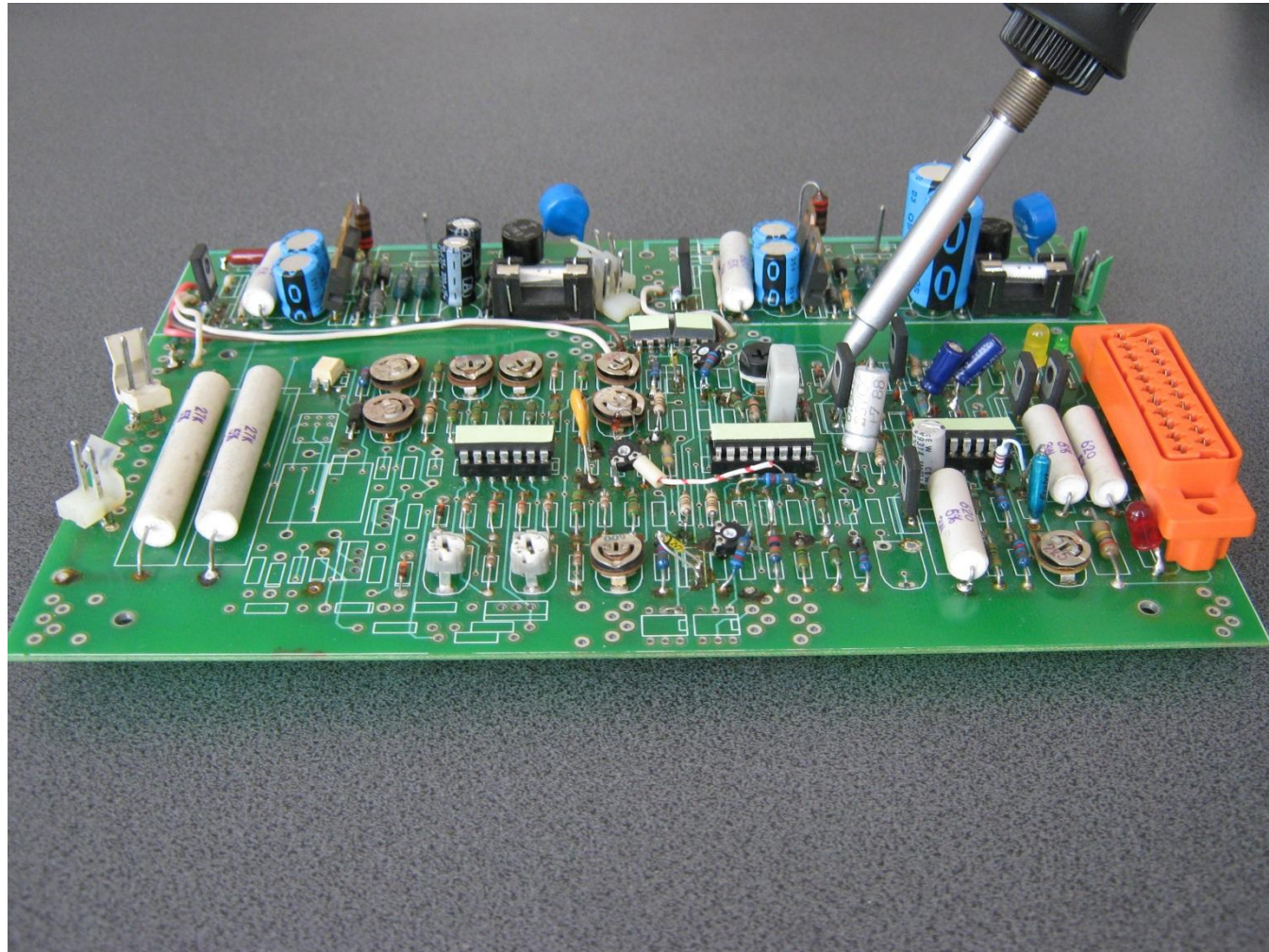
# ***Fig.1.3. Soldering wire connections and terminal pads on a PCB of a DC servomotor drive***

- ◆ ***Electric  
copper bit or  
temperature-  
controlled  
iron  
soldering  
process***
- ◆ ***Filler alloy:  
S-Sn96Ag3Cu1,  
according to  
EN ISO 3677  
and  
EN ISO 9453***
- ◆ ***Flux:  
colophon***



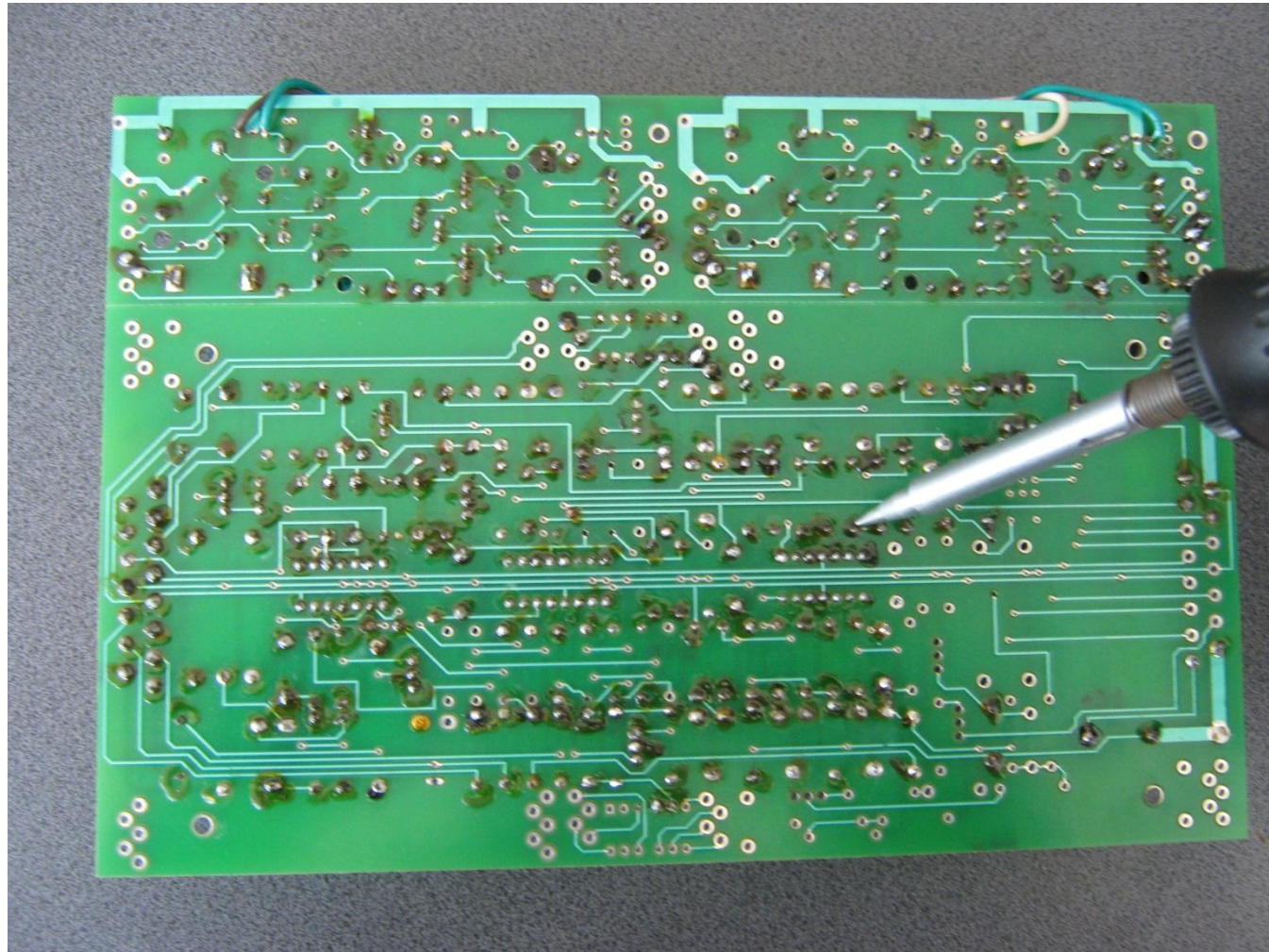
# ***Fig.1.4. Soldering wire connections and terminal pads on a PCB of an experimental supply source***

- ◆ ***Electric temperature-controlled iron soldering process***
- ◆ ***Filler alloy: S-Sn96Ag3Cu1, according to EN ISO 3677 and EN ISO 9453, and S-Sn90In7Ag3, elaborated in the Ecosolder project***
- ◆ ***Flux: colophon***



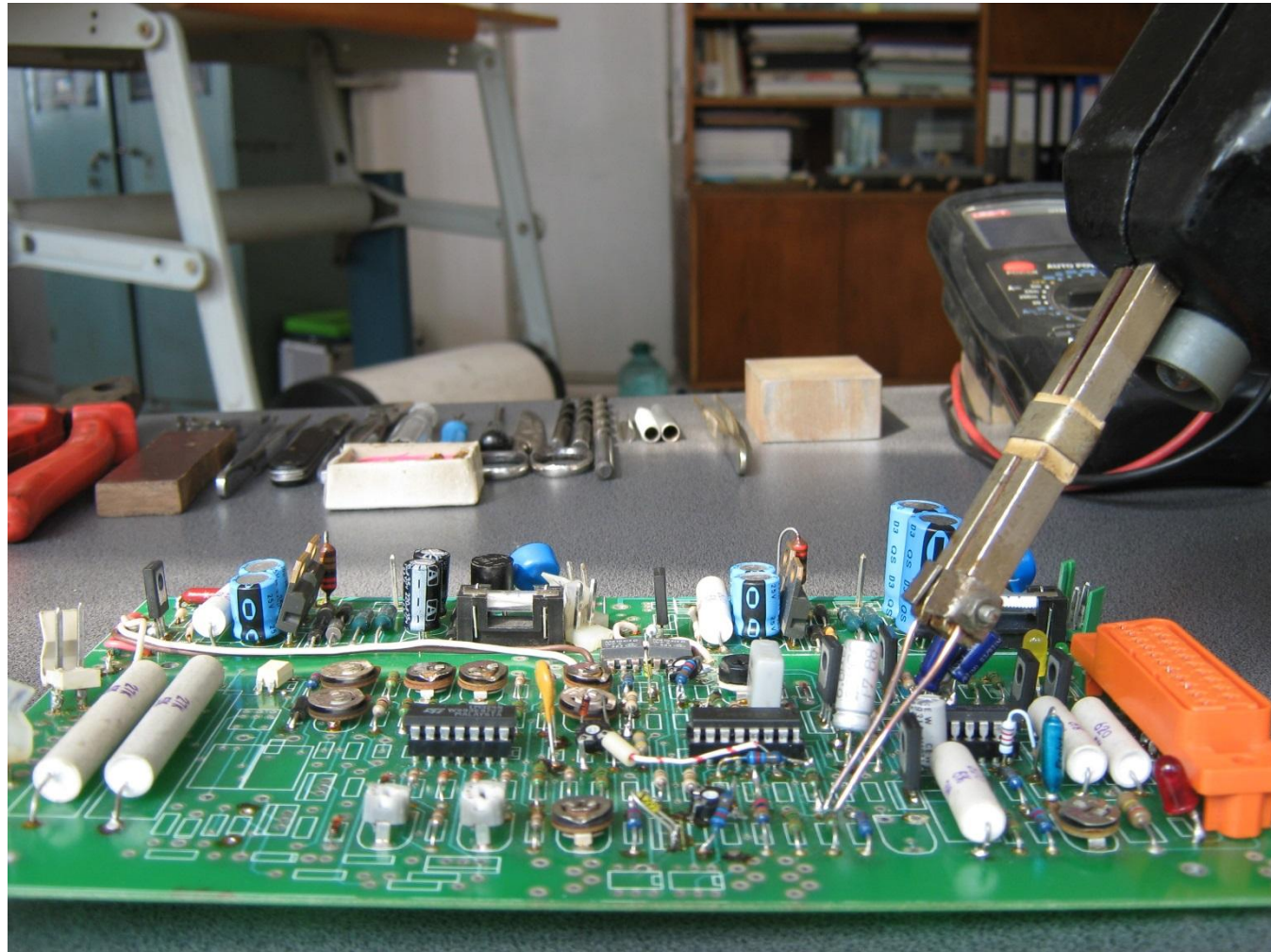
# ***Fig.1.5. Soldering of terminal pads on the connection side of a PCB of an experimental supply source***

- ◆ ***Electric temperature-controlled iron soldering process***
- ◆ ***Filler alloy: S-Sn96Ag3Cu1, according to EN ISO 9453, as well as S-Sn90In7Ag3, elaborated in the Ecosolder project***
- ◆ ***Flux: colophon***



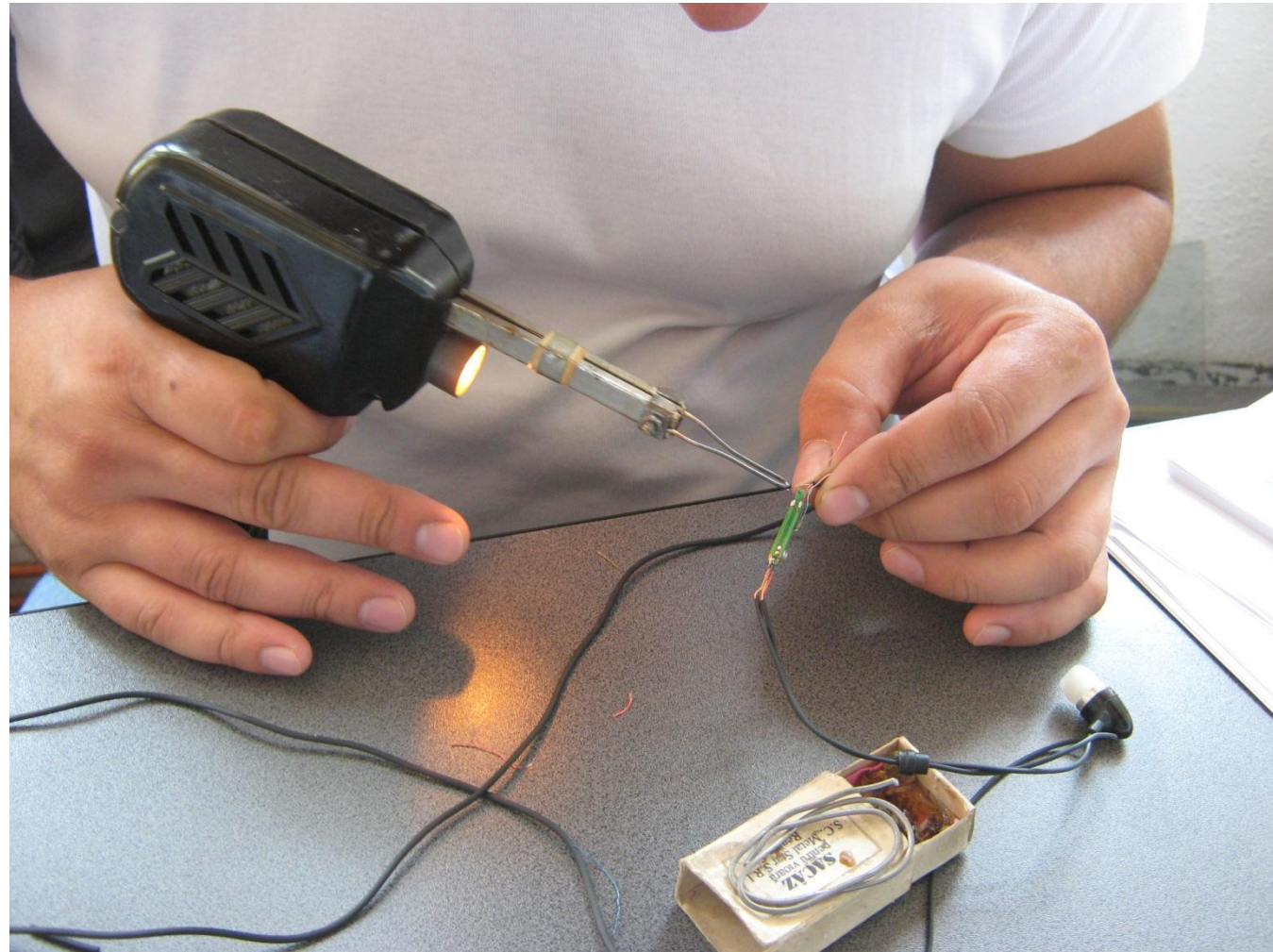
# ***Fig.1.6. Soldering of terminal pads on the component side of a PCB of an experimental supply source***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn96Ag3Cu1, according to EN ISO 9453, as well as S-Sn90In7Ag3, elaborated in the Ecosolder project***
- ◆ ***Flux: colophon***



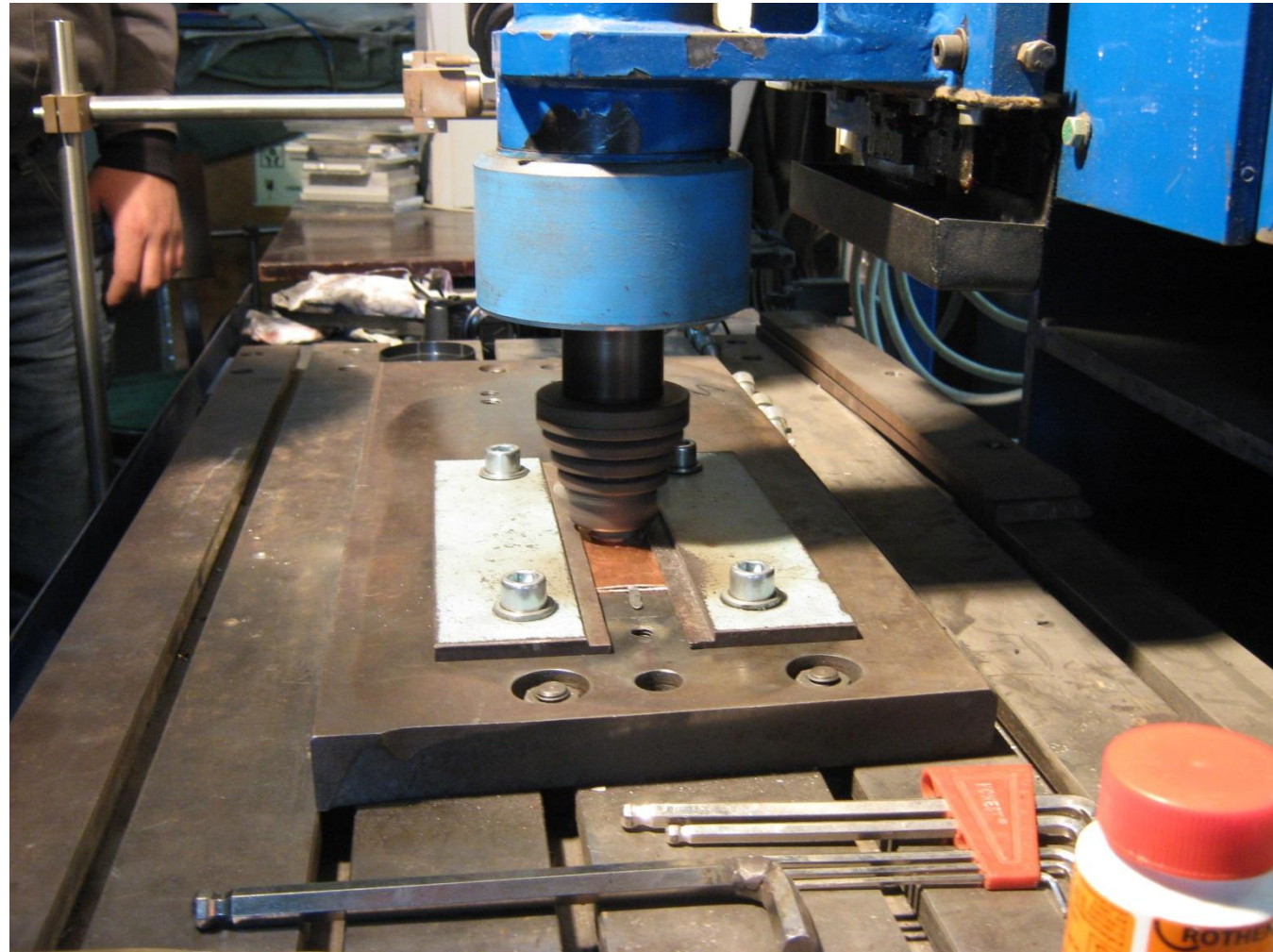
## ***Fig.1.7. Soldering a wire connection of an earphone***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn96Ag3Cu1, according to EN ISO 9453***
- ◆ ***Flux: colophon***



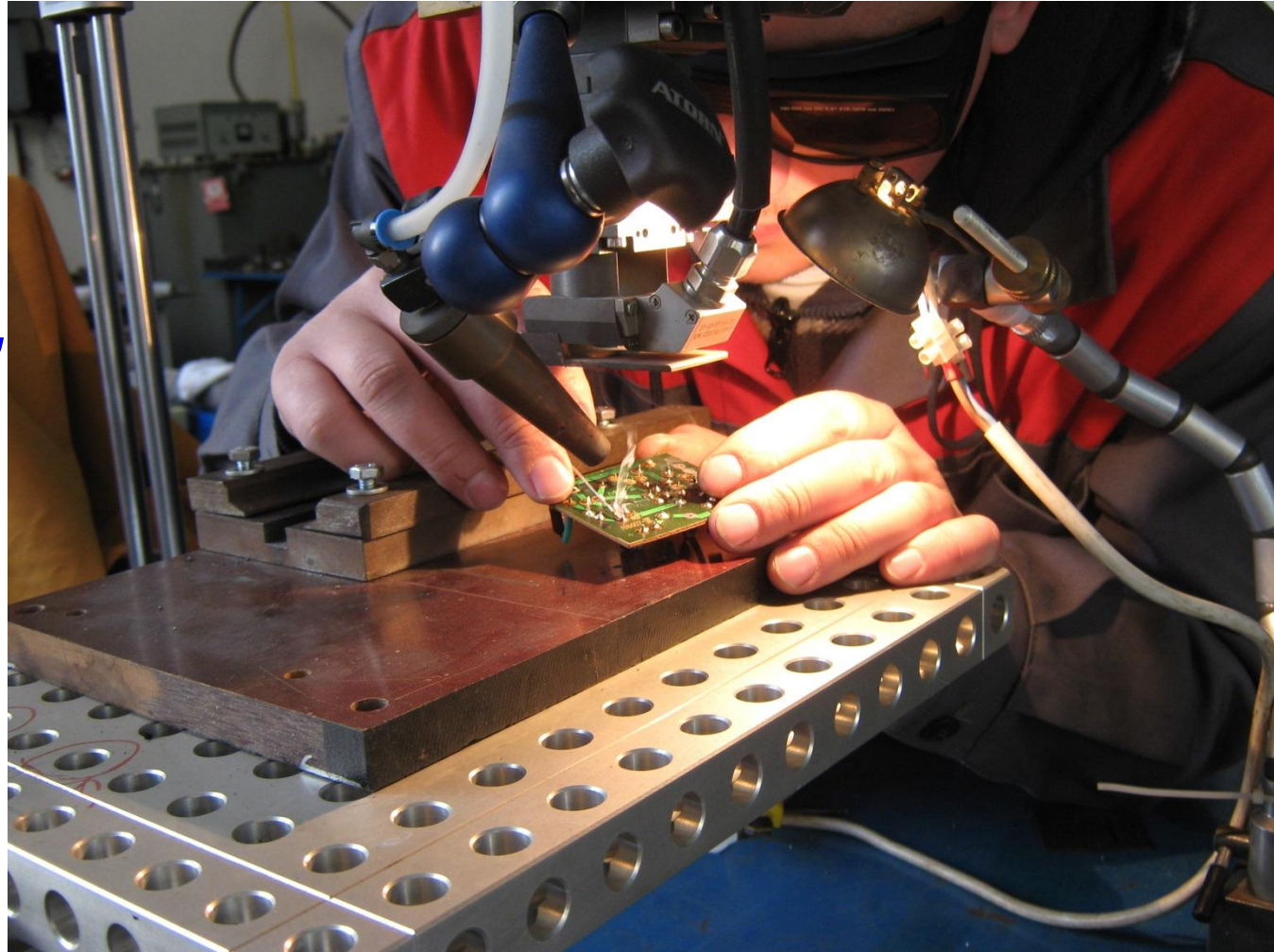
## ***Fig.1.8. Friction stir soldering (FSS) of overlapped steel sheets***

- ◆ ***Friction stir soldering (FSS) process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 3677 and EN ISO 9453***
- ◆ ***Flux: Rosol 3, EN ISO 9454***



## ***Fig.1.9. Laser soldering on a PCB of an electronic time relay***

- ◆ ***Laser soldering process***
- ◆ ***Filler alloy: S-Sn96Ag3Cu1, according to EN ISO 3677 and EN ISO 9453***
- ◆ ***Flux: colophon***
- ◆ ***Gas protection: argon***



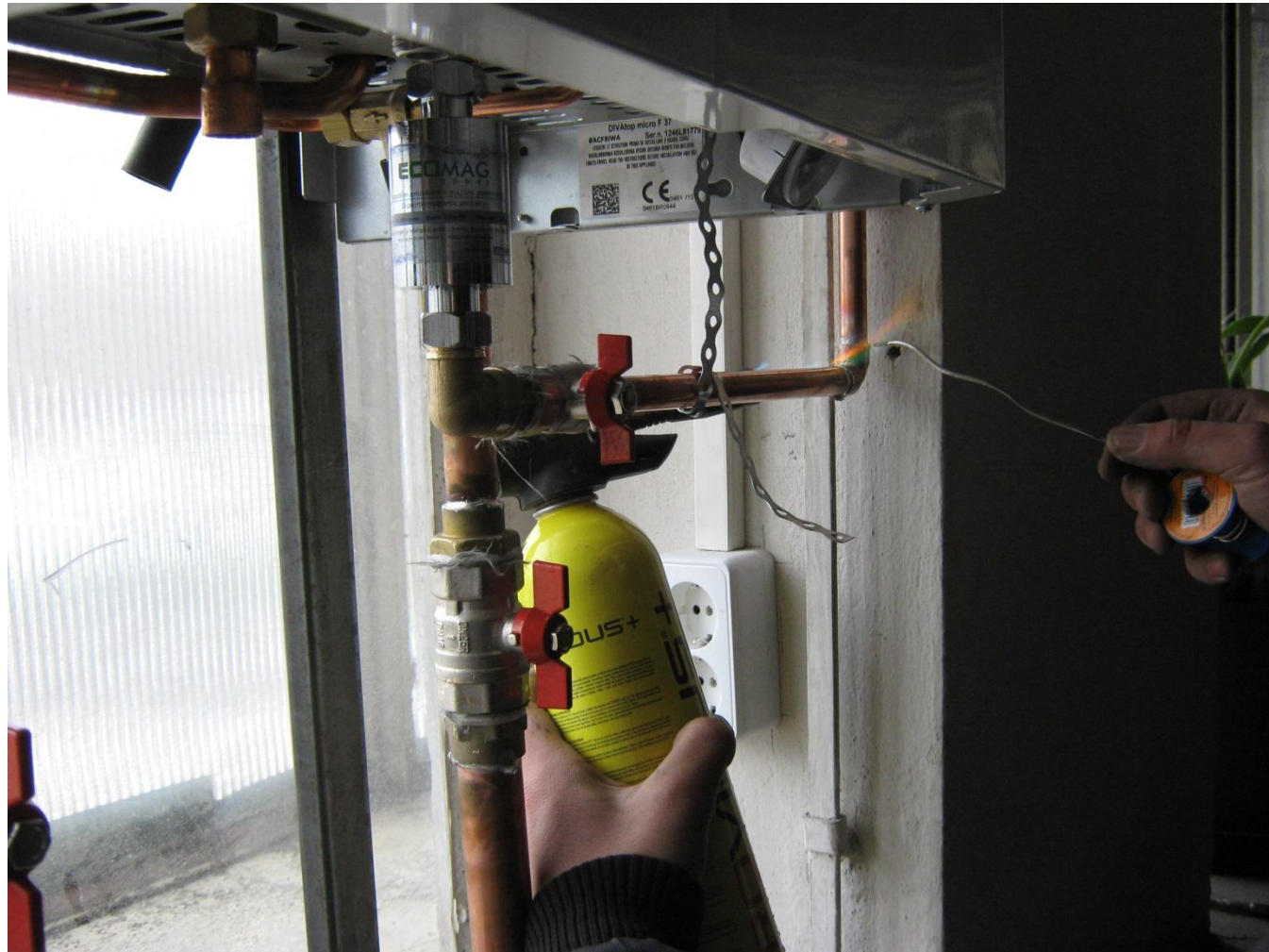
## ***Fig.1.10. Flame soldering of tubes of a heating installation***

- ◆ ***MAPP gas flame soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 3677 and EN ISO 9453***
- ◆ ***Flux: Rosol 3, EN ISO 9454***



## ***Fig.1.11. Flame soldering of fittings of a heating installation***

- ◆ ***MAPP gas  
flame  
soldering  
process  
in constraint  
positions***
- ◆ ***Filler alloy:  
S-Sn97Cu3,  
according to  
EN ISO 9453***
- ◆ ***Flux: Rosol 3,  
EN ISO 9454***



## ***Fig.1.12. Flame-soldered tubes and fittings of a heating installation***

- ◆ ***MAPP gas flame soldering process in constraint positions***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: Rosol 3, EN ISO 9454***



## ***Fig.1.13. Steel strips prepared for electric copper bit soldering***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: colophon***



## ***Fig.1.14. Steel strips in the jig for electric copper bit soldering***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: colophon***



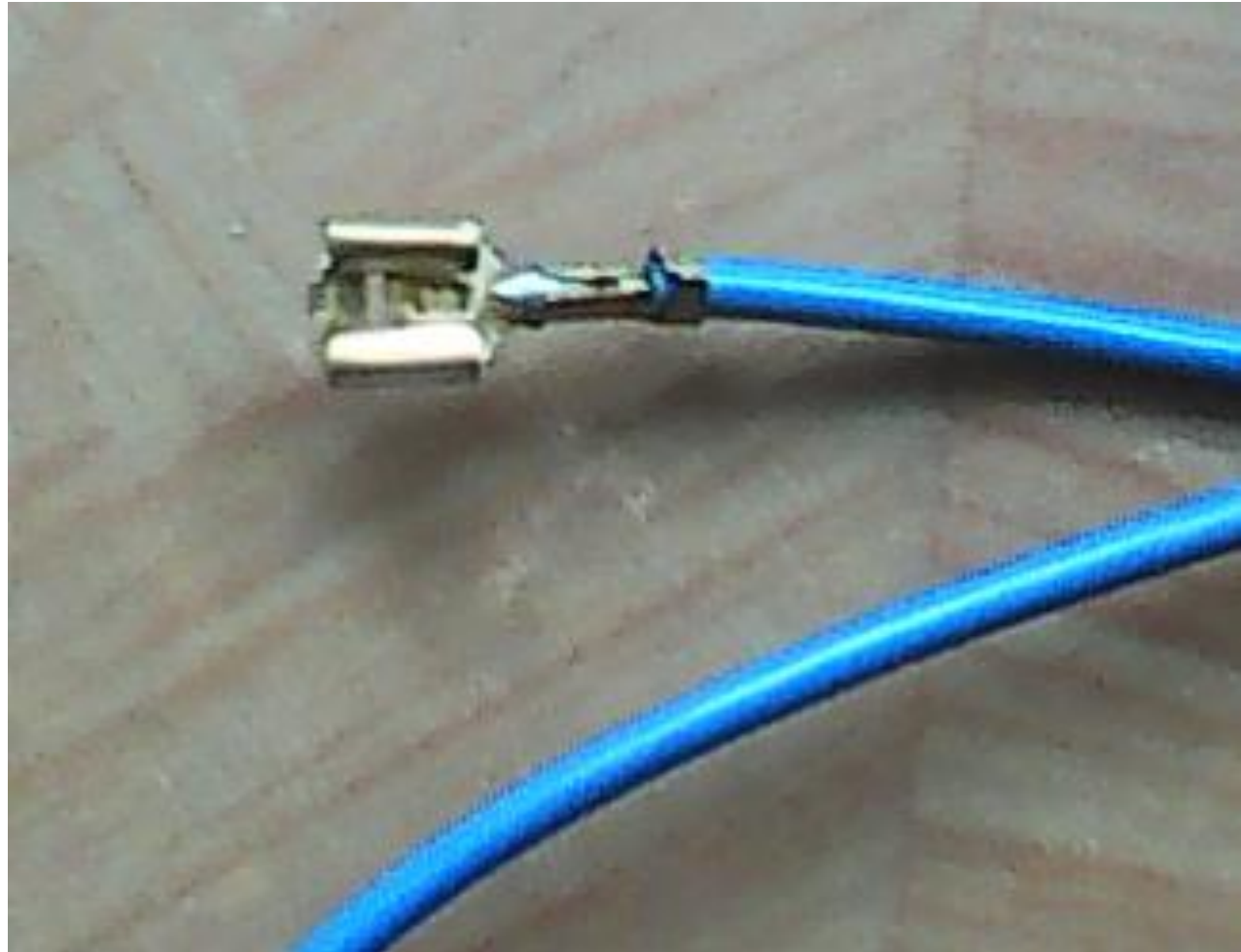
## ***Fig.1.15. Soldered joint of steel strips, after a bending test***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: colophon***



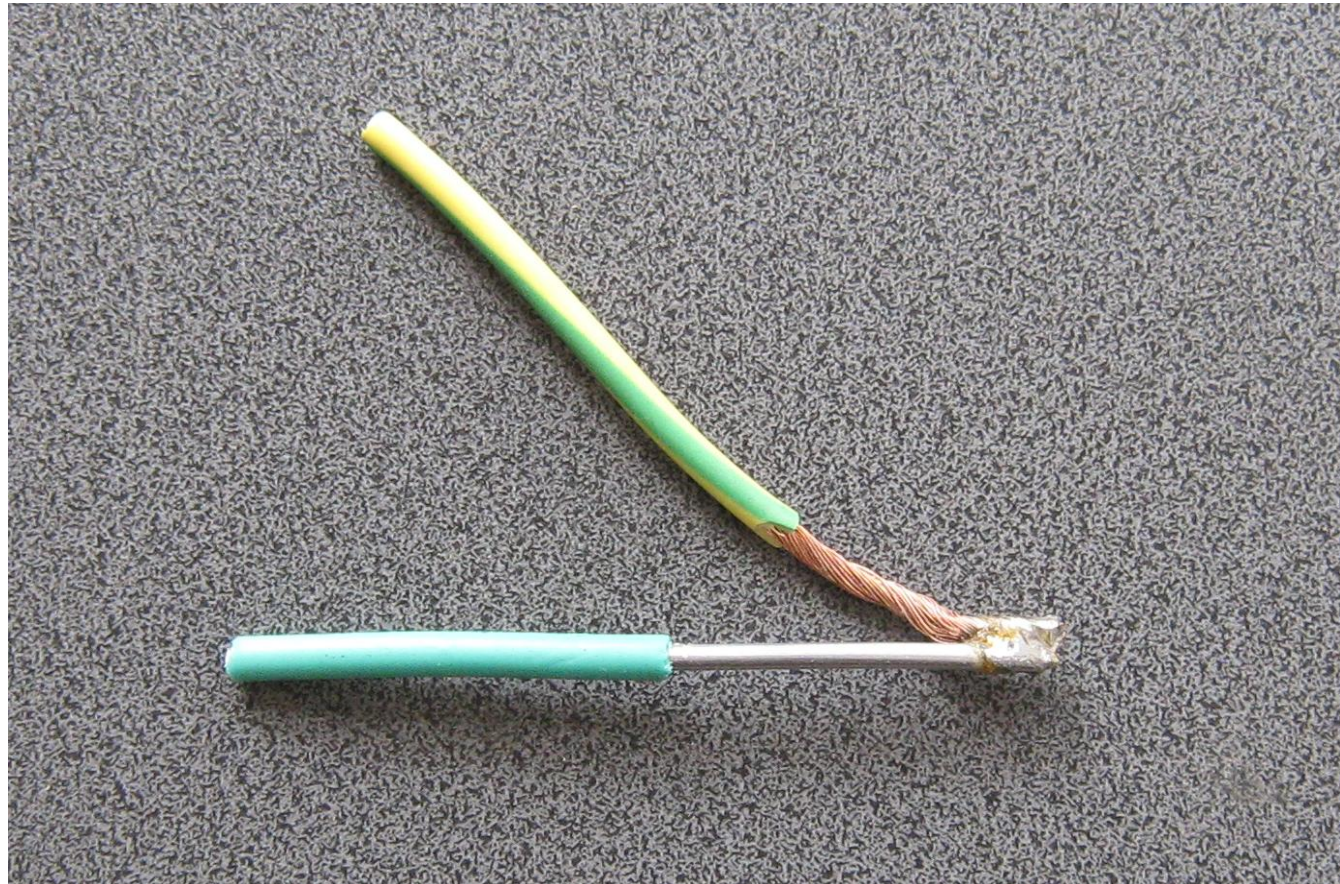
## ***Fig.1.16. Electric copper bit soldering of electric lugs and shoes***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: colophon***



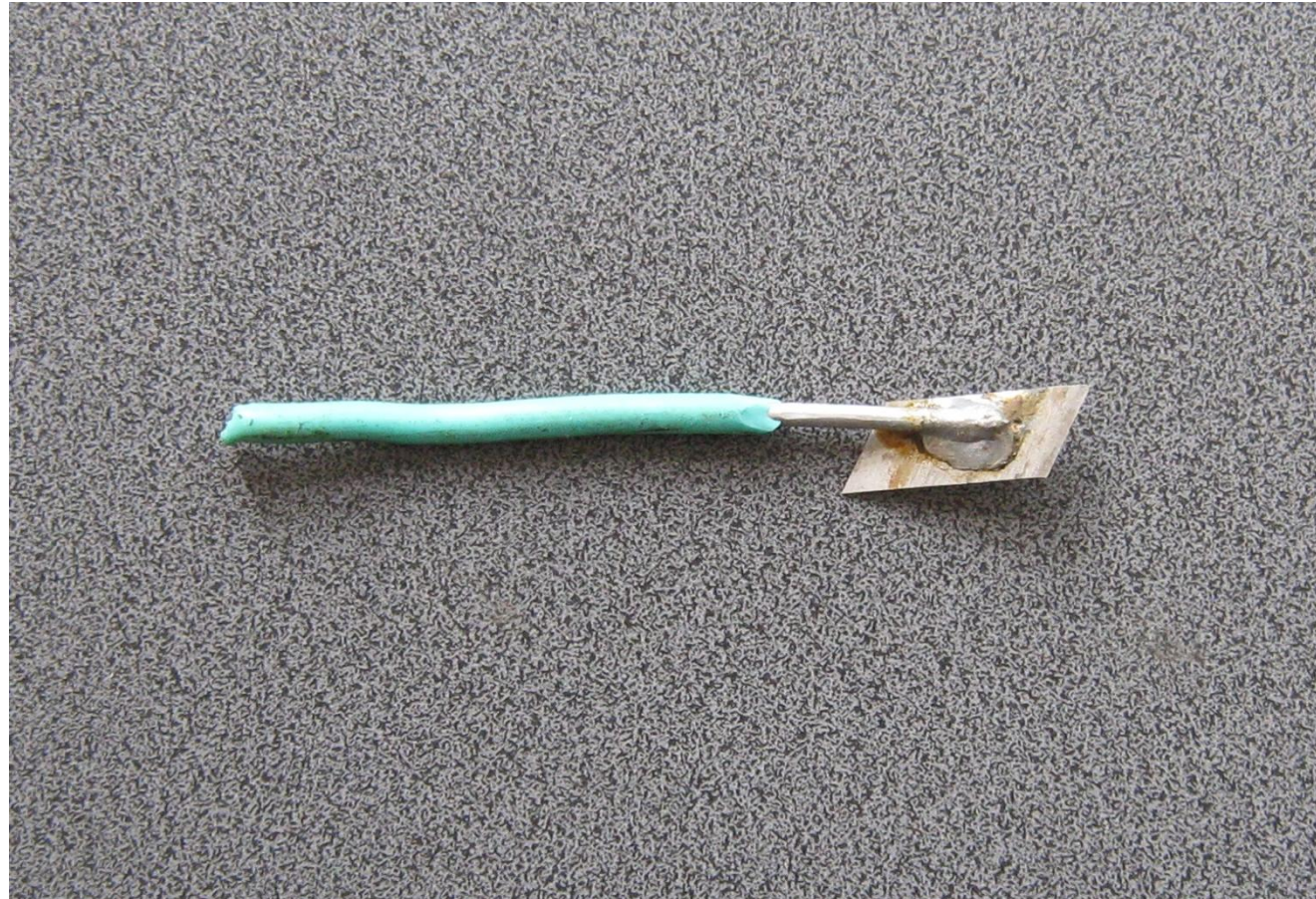
# ***Fig.1.17. Dissimilar joint of aluminium wire to copper wire by electric copper bit soldering***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 3677 and EN ISO 9453***
- ◆ ***Flux: Alutin 51 according to EN ISO 9454***



# ***Fig.1.18. Dissimilar joint of aluminium wire to steel blade by electric copper bit soldering***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: Alutin 51***



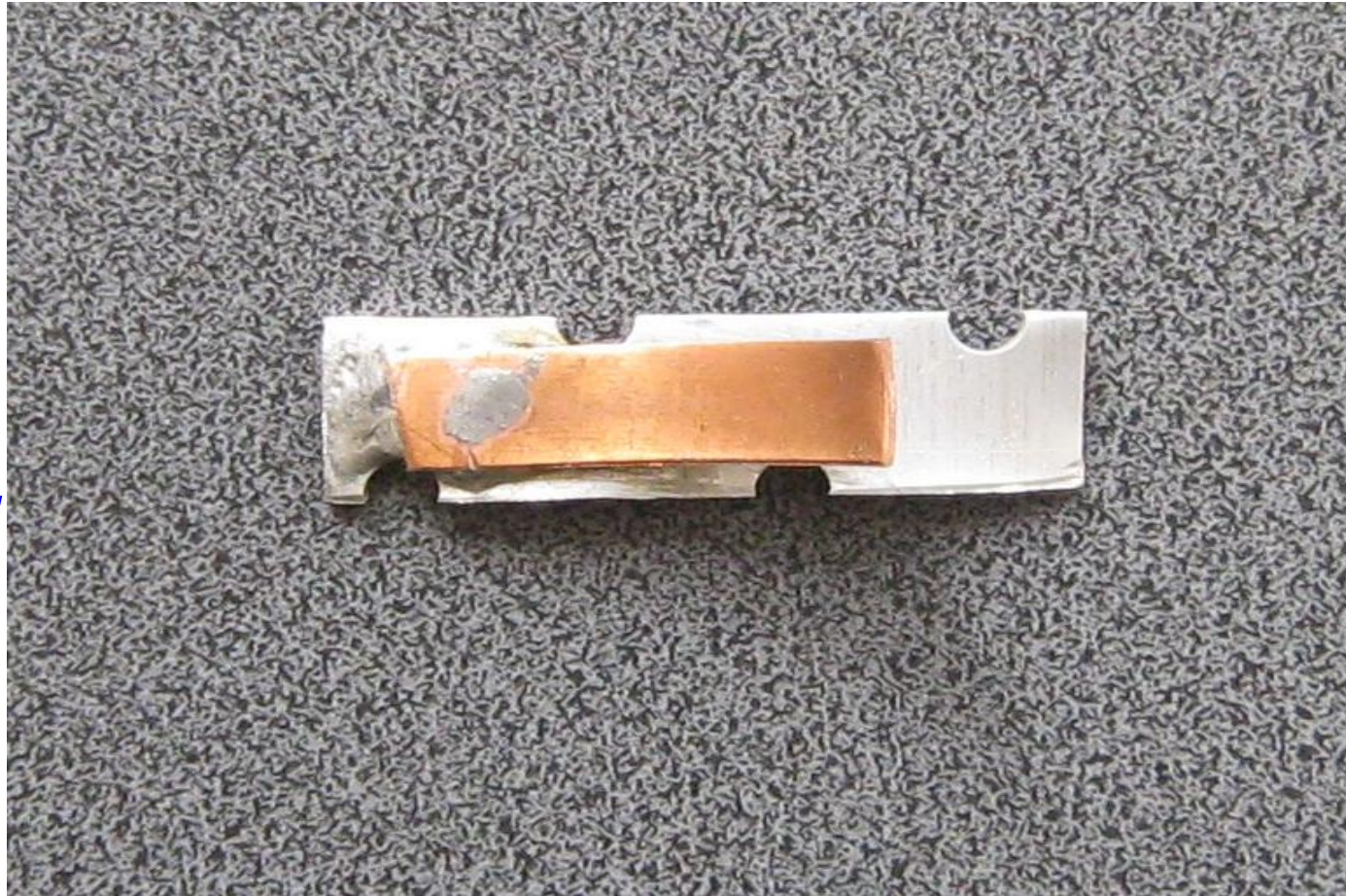
# ***Fig.1.19. Dissimilar joint of aluminium blade to brass blade by electric copper bit soldering***

- ◆ ***Electric copper bit soldering process***
- ◆ ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ◆ ***Flux: Alutin 51***



# ***Fig.1.20. Dissimilar joint of aluminium clamp to copper blade by electric copper bit soldering***

- ***Electric copper bit soldering process***
- ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ***Flux: Alutin 51***



# ***Fig.1.21. Dissimilar joint of aluminium clamp to brass blade by electric copper bit soldering***

- ***Electric copper bit soldering process***
- ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ***Flux: Alutin 51***



# ***Fig.1.22. Similar joint of aluminium clamp to aluminium clamp by electric copper bit soldering***

- ***Electric copper bit soldering process***
- ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ***Flux: Alutin 51***



# ***Fig.1.23. Soldering steel blades, with measuring gases and fumes concentration***

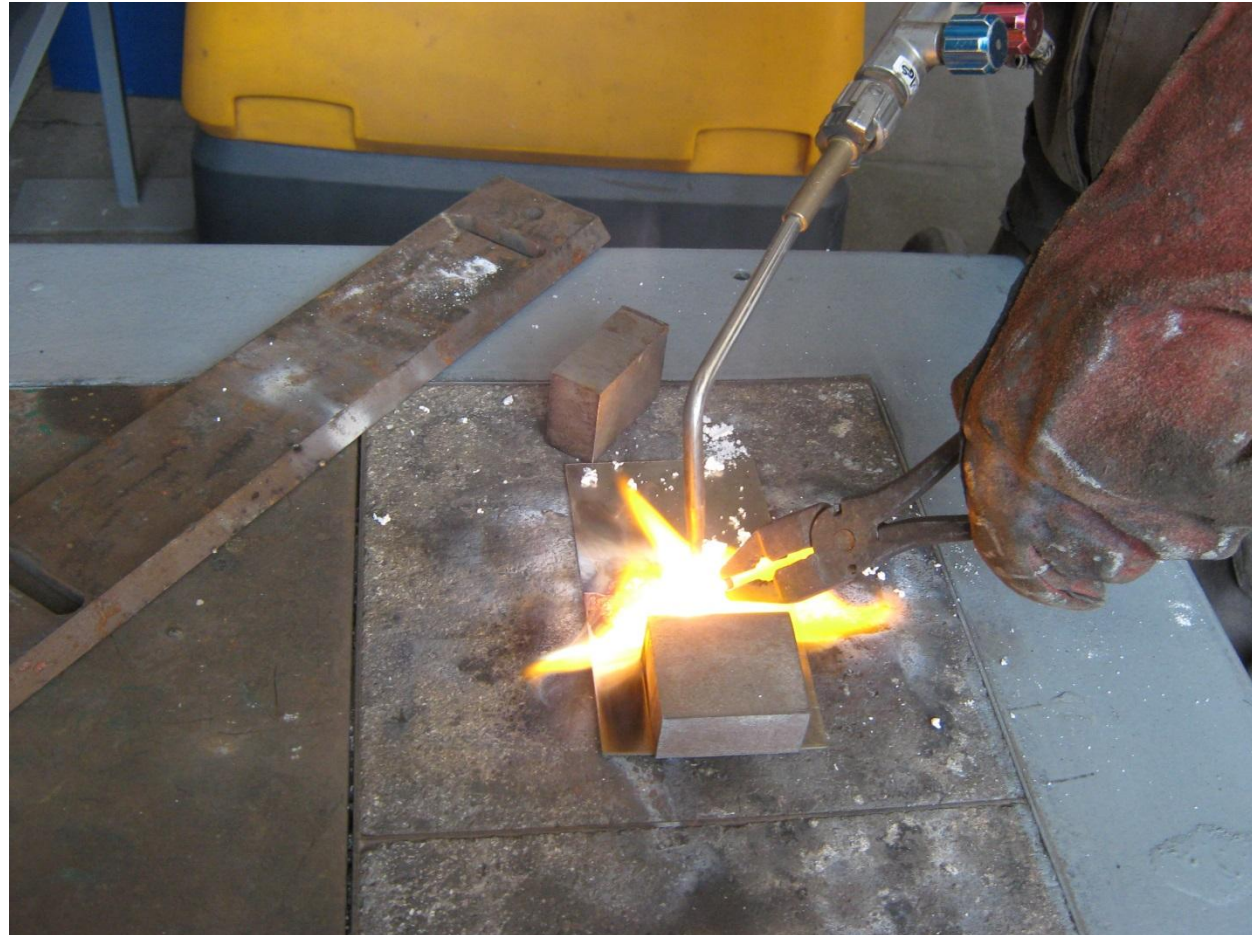
- ***Electric copper bit soldering process***
- ***Filler alloy: S-Sn97Cu3, according to EN ISO 9453***
- ***Flux: colophon***
- ***Mobile system for measuring gases and fumes***



## **2. Brazing applications.**

### **Fig.2.1. Butt-joint flame brazing of steel sheets**

- **Oxygen-acetylene flame brazing process**
- **Filler alloy: B-CuZnSnSiMn, according to EN ISO 3677 and EN ISO 17672, elaborated in the Ecosolder project**
- **Flux: borax, EN 1045**



## ***Fig.2.2. Fillet-joint flame brazing of steel sheets***

- ◆ ***Oxygen-acetylene flame brazing process***
- ◆ ***Filler alloy: B-CuZnSnSiMn, according to EN ISO 3677 and EN ISO 17672, elaborated in the Ecosolder project***
- ◆ ***Flux: borax***



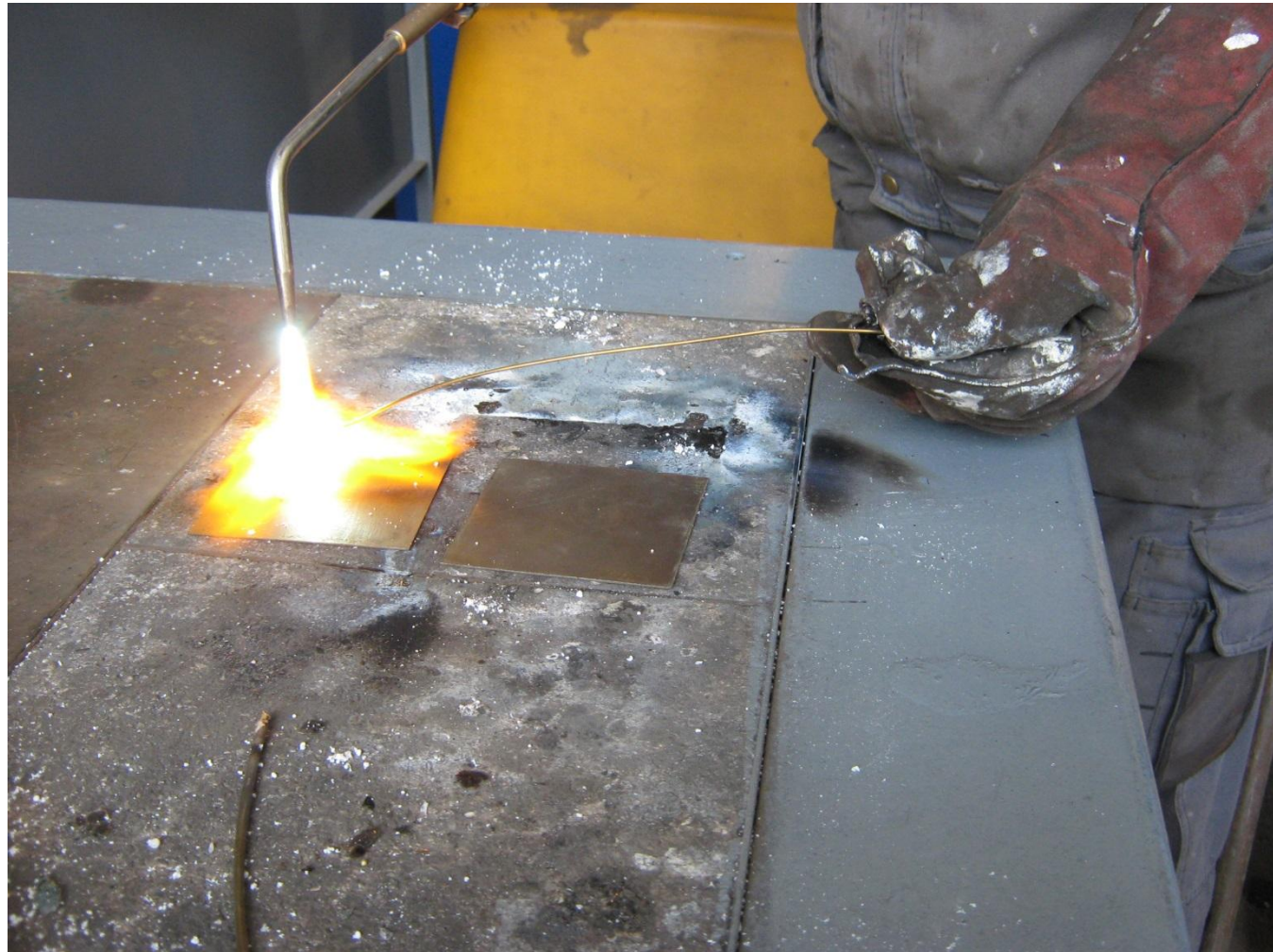
## ***Fig.2.3. T-joint flame brazing of steel sheets***

- ***Oxygen-acetylene flame brazing process***
- ***Filler alloy: B-CuZnSnSiMn, according to EN ISO 3677 and EN ISO 17672, elaborated in the Ecosolder project***
- ***Flux: borax***



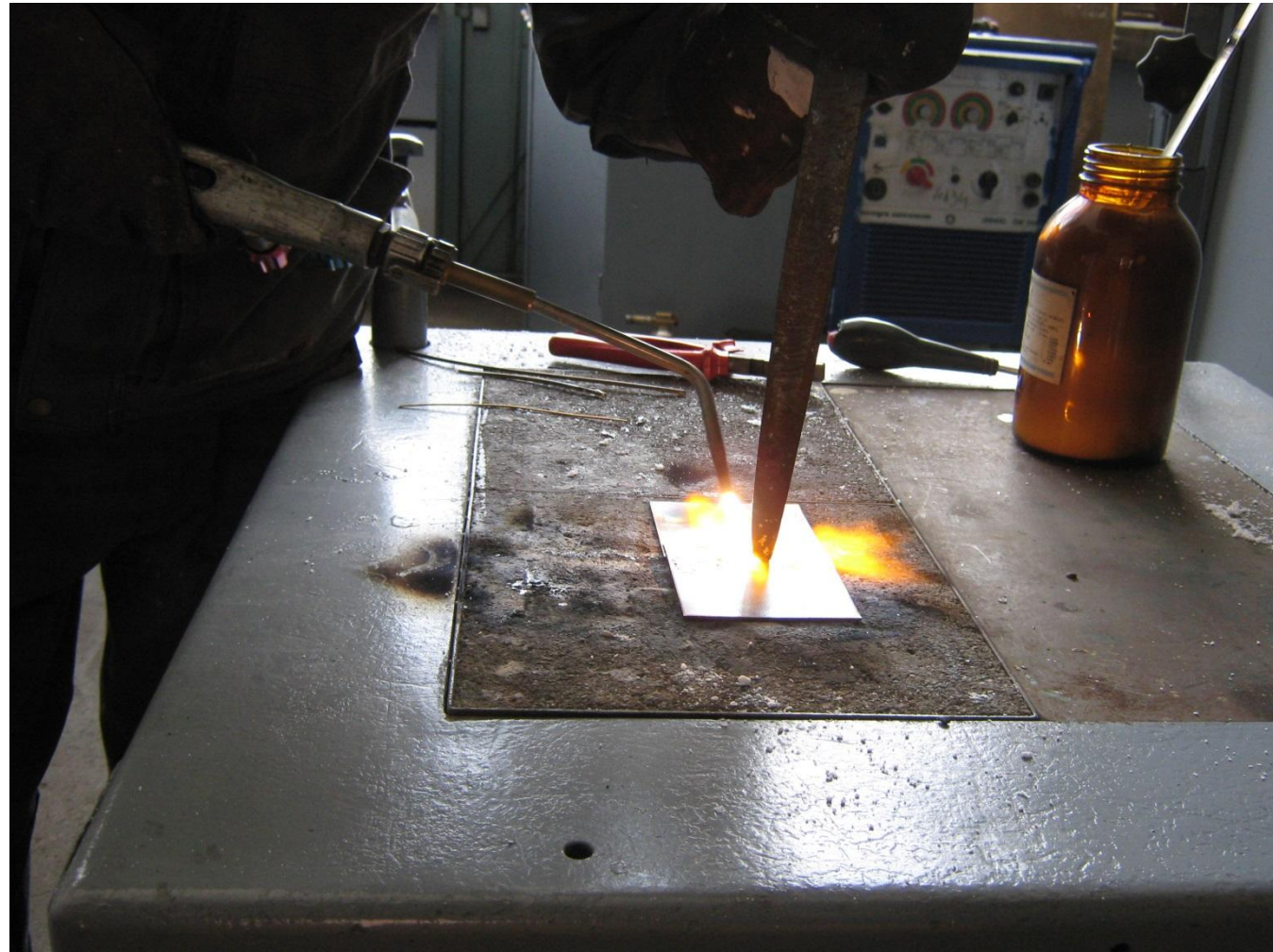
## ***Fig.2.4. Depositing brass as a phase of overlap-joint flame brazing of steel sheets***

- ◆ ***Oxygen-acetylene flame brazing process***
- ◆ ***Filler alloy: B-CuZnSnSiMn, according to EN ISO 3677 and EN ISO 17672, elaborated in the Ecosolder project***
- ◆ ***Flux: borax***



## ***Fig.2.5. Pressing the sheets as a phase of overlap joint flame brazing of steel sheets***

- ◆ ***Oxygen-acetylene flame brazing process***
- ◆ ***Filler alloy: B-CuZnSnSiMn, according to EN ISO 3677 and EN ISO 17672, elaborated in the Ecosolder project***
- ◆ ***Flux: borax***



## ***Fig.2.6. Overlap-joint flame brazing of steel sheets***

- ◆ ***Oxygen-acetylene flame brazing process***
- ◆ ***Filler alloy: B-Cu63Zn37, according to EN ISO 3677 and EN ISO 17672,***
- ◆ ***Flux: borax***



## ***Fig.2.7. Flame-brazed electric shoe of the power connections of a furnace***

- ◆ ***Flame brazing process***
- ◆ ***Filler alloy:  
B-Ag40CuZn,  
according to  
EN ISO 3677  
and  
EN ISO 17672***
- ◆ ***Flux: borax***



## ***Fig.2.8. Flame-brazed electric shoes in the power connections of a furnace***

- ◆ ***Flame brazing process***
- ◆ ***Filler alloy:  
B-Ag40CuZn,  
according to  
EN ISO 3677  
and  
EN ISO 17672***
- ◆ ***Flux: borax***



## ***Fig.2.9. WIG weld-brazing titanium parts on an aluminium beam***

- ◆ ***WIG weld-brazing process***
- ◆ ***Filler alloys: aluminium, copper, brass and tin alloy rods***
- ◆ ***Protection gas: argon***



# ***Fig.2.10. Brazing of steel sheets, with monitoring the concentration of gases and fumes***

- ***Oxygen-acetylene flame brazing process***
- ***Filler alloy: B-Ag40CuZnSn flux-coated rod, 2.0mm diameter, according to EN ISO 17672 and EN 1045***
- ***Measuring gases and fumes***



### **3. Conclusions**

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- 1. The new ecological filler alloys for soldering and brazing, respectively the solder S-Sn90In7Ag3 and the brass B-CuZnSnSiMn have been elaborated by the Mining and Metallurgy Institute - MMI Bor, Serbia, partner of the Ecosolder project.***
- 2. The soldering and brazing procedures for the presented applications have been elaborated and executed in a program of experiments by the National Research & Development Institute for Welding and Material Testing - ISIM Timisoara, Romania, the lead partner of the Ecosolder project.***

### **3. Conclusions (continued)**

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- 3. Visual examination, according to EN 12799:2000 [17], of the brazed joints was carried out by ISIM. The appearance of the joints is adequate and no defects have been detected.**
  - 4. Metallographic analysis according to SR EN 12797, SR EN ISO 18279 and SR 5000-97, Vickers hardness test according to SR EN ISO 6507-1 and shear test according to SR EN 25239-4;5 have been performed by ISIM, for the brazed joints. The results are adequate.**
  - 5. The partners of the Ecosolder project recommend the presented applications for the target groups of the industry and services.**
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# References

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- [1] Groover, Mikell P. (2007). *Fundamentals Of Modern Manufacturing: Materials, Processes and Systems* (2nd ed.). John Wiley & Sons. ISBN 978-81-265-1266-9.**
- [2] P.M. Roberts, "Industrial Brazing Practice", CRC Press, Boca Raton, Florida, 2004.**
- [3] \*\*\* Brazing. [en.wikipedia.org/wiki/Brazing](http://en.wikipedia.org/wiki/Brazing)**
- [4] \*\*\* The Oxy-Acetylene Handbook, Union Carbide Corp.**
- [5] L. Boțilă; V. Verbițchi et al.: Project ECOSOLDER. MIS Code 1409. „Promoting new ecological filler alloys for soldering, based on the non-ferrous ore of the Romanian-Serbian cross-border area”. Technical Report. Stages 1; 2; 3; 4; 5. ISIM Timisoara, Romania. 2013- 2014.**
- [6] A. Kostov; R. Todorovic; A. Milosavljevic et. al. (MMI Bor, Serbia): “New ecological solder CuZnSnSiMn”. Leaflet presented at the Workshop #1, organized by ISIM Timisoara, February 2014.**
- [7] EN 13134:2000 - Brazing - Procedure approval.**
- [8] EN ISO 13585:2012 - Brazing - Qualification test of brazers and brazing operators.**
- [9] EN 14324:2004 - Brazing - Guidance on the application of brazed joints.**

# ***References (continued)***

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- [10] EN ISO 3677:1995 - Filler metal for soft soldering, brazing and braze welding - Designation (ISO 3677:1992).***
- [11] EN ISO 9453:2006 - Soft solder alloys - Chemical compositions and forms.***
- [12] EN ISO 9454-2:2000- Soft soldering fluxes- Classification and requirements - Part 2: Performance requirements.***
- [13] EN ISO 17672:2010 - Brazing. Filler metals.***
- [14] EN 1045:1997 - Brazing - Fluxes for brazing - Classification and technical delivery conditions.***
- [15] EN 12799:2000- Brazing - Non-destructive examination of brazed joints (& A1:2003)***
- [16] ISO 5187:1985 - Welding and allied processes - Assemblies made with soft solders and brazing filler metals - Mechanical test methods.***
- [17] EN 12797:2000 Brazing - Destructive tests of brazed joints (& A1:2003).***

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**Thank you for your attention !**

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