COST Action MP0602
Advanced Solder Materials for High Temperature Application - HISOLD

GROUP PROJECT PROPOSALS

The COST Action MP0602 “Advanced Solder Materials for High Temperature Application”

Working Group 2 - Properties of solder joints

Annex 1

1. INFORMATION EXPECTED FOR A GROUP PROPOSAL

1.1 Title of project:

LEAD-FREE SOLDER JOINTS QUALITY, FUNCTIONALITY AND RELIABILITY AS FUNCTION OF HISOLD MATERIALS SOLDERING ON DIFFERENT PAD FINISHES FOR DIFFERENT SOLDERING PROCESS PARAMETERS

Acronym of the Group Project: **HISOLD 4P-Q&R**

Coordinator:

Paul Svasta / Ioan Plotog
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1.2 Information on participating members

1.2.1. **Participant 1**

1.2.1.1. **Prof. Paul Svasta**
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1.2.1.2. **Ioan Plotog,**
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1.2.1.3 Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: **1x Professor, 2x PhD student, 2x researchers, 1x technician**

1.2.1.4. Expected cost of project:

1.2.2 **Participant 2**

1.2.2.1. **Prof. Jürgen Villain**

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1.2.2.2. Scientist responsible for the project (if different from the applicant). Full name, title, office, complete address, Telephone fax and e-mail.

1.2.2.3. Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: ……………………………………………….

1.2.2.4. Expected cost of project:

1.2.3. **Participant 3**

1.2.3.1. **Prof. Gábor Harsányi**

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1.2.3.2. **Prof. Zsolt Illyefalvi-Vitez**

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1.2.3.3. Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: **2x Professor, 3x PhD student, 2x researchers, 2x technician**

1.2.3.4. Expected cost of project:

1.2.5. **Participant 4**

1.2.5.1. **Assoc. Prof. Mihai Branzei**

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1.2.5.2. **Florin Miculescu**

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1.2.5.3. Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: **1x Assoc. Prof., 1x Lecturer, 1x Assistant, 1x Researcher**

1.2.5.4. Expected cost of project:

1.2.6. **Participant 5**
1.2.6.1. **Prof. Alena Pietrikova**
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1.2.6.2. Scientist responsible for the project (if different from the applicant). Full name, title, office, complete address, Telephone fax and e-mail.
1.2.6.3. Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: **1x Professor, 2x PhD students, 4x researchers, 2x technicians.**
1.2.6.4. Expected cost of project:

1.2.7. **Participant 6**
1.2.7.1. **Prof. Dan Mihai Constantinescu**
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1.2.7.2. Scientist responsible for the project (if different from the applicant).
1.2.7.3. Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: **1x Professor, 2xAssoc. Prof., 2x PhD students, 2x researchers.**
1.2.7.4. Expected cost of project:

1.2.8. **Participant 7**
1.2.8.1. **Prof. Corneliu Balan**
CENTER FOR ENERGETICS RESEARCH AND ENVIROMENT PROTECTION, UPB-CCEPM, REOROM Laboratory, "FIELD-MATTER INTERACTION" Laboratory – BIOINGTEH Platform, "Politehnica" University of Bucharest, UPB, Hydraulics Department, Splaiul Independentei 313, 060042 Bucharest, Romania, Phone: 021.402.9705; Fax: 021.402.9865;
E-mail: balan@hydrop.pub.ro
1.2.8.2. Scientist responsible for the project (if different from the applicant). Full name, title, office, complete address, Telephone fax and e-mail
1.2.8.3. Expected effort in man/years per annum of research students, post doctoral researchers, scientists and technicians: **1xProfessor, 1xPhD**
1.2.8.4. Expected cost of project:

1.4 Start date. 27.08.2007

1.5 International co-operation with other Signatory States of the Memorandum of Understanding (if not mentioned above)

Will be establishing an active international co-operation with minimum 10 partners from 6 Countries and/or companies:

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1.5.2. Prof. Gabriella Borzone, Italy
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1.5.3. Dr. Nele Moelans, Belgium
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1.5.8. Dag Andersson, Swerea IVF, Argongatan 30, SE-431 53 Mölndal, Sweden, Phone +46 31-706 60 00, Fax +46 31-27 61 30 E-mail: Dag.Andersson@swerea.se
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1. ABSTRACT

The quality and reliability of microelectronics components and assemblies can be considered as expression of solder joints functionality. These properties are in close connection with the microstructure of the solder joints, which are the result of the soldering **P**rocess temperature gradient action over the trinomial solder alloy/**P**aste, electronic components terminals/**P**in and PCBs **P**ads finishes (**4P Soldering Model**). The temperature gradient will be determinate by the specific thermal profile of the soldering process. As part of WG2, the **HISOLD 4P-Q&R** Group project will investigate the properties of solder joints realized by different **Paste-Pad-Pin-Process** reflow soldering formula with a special focus on lead-free solder alloys with Zn and Bi as well as nanoparticles content, before and after complex electrical, mechanical and climatic tests. Proposal for solder joints functionality standard test methods, test vehicles and data bases will be elaborated as result of environmental stress studies, thermodynamical, rheological and microstructural solder joints analyses, optical and X-Ray inspection, based on IPC references. A standard SAC solder alloy and the reflow soldering process will be used as reference. As a consequence, the DFM concept can be improved with practical manufacturing requirements.

2. INFORMATION EXPECTED IN EACH PROPOSAL

3.1 Aim of the study (approx. ½ page)

The scope of the GP/WG2 - HISOLD 4P-Q&R are studies of solder joints as result of soldering process action over the trinomial parts - solder alloy/**P**aste, electronic components terminals (**P**in) and metallic substrate (**P**ad) - in the Printed Circuit Boards (PCBs) assembling lines, as function of soldering **P**rocess parameters by promoting **4P SOLDERING MODEL (Paste-Pin-Pad-Process)** for solder joints analysis.

Three main results are expected from investigations carried out as joint actions of the participants of the GP/WG2 - HISOLD 4P -Q&R:

- **Data base**, containing the applied materials and process parameters as well as tests results, including:
  - Materials properties of the investigated 4P structures.
  - Well-defined description of the applied test vehicles.
  - Well-defined description of the applied parameters of the soldering processes.
  - Well-defined description of the applied test methods and set-up parameters.
  - The functional, quality and reliability data, including photos and diagrams where applicable, of the test and analysis results.
  - Results of the theoretical simulations.
  - Interpretation, explanations and comments of the investigators regarding the test results.
- **Proposals and recommendation**s for the application of:
  - Lead-free solder and 4P materials for normal, low and high temperature applications.
  - Standardized test vehicles for further investigations.
  - Recommended methods for the analyses of the specific joints or process parameters.
  - Recommendation for the application of best simulation and evaluation tools.

  As consequence, can be propose standard methods and test vehicles to evaluate solder materials and assembling processes
- Improvement and **application of the Design for Manufacturing (DFM) concept** by
  - The definition of design rules.
  - Definition and recommendation of best manufacturing practices.

3.2. Background to the study (suggested 1-2 pages)

Present state of knowledge; review of the literature and relevant work in progress elsewhere; novelty in the proposed program.

For the time being the lead-free technology introduced its way throughout most of the assembly manufacturers followed by the awareness of the lead free reliability to be taken into account as an important factor for the solder alloy/paste and material choice. Although not fully documented as the time since the beginning of lead free mass usage was too short in order to draw an ultimate behavior pattern for the various alloys, more and more entities are showing a growing interest in the alloy choice based on the reliability factors especially when in conjunction with the financial ones. For the electronic industry, one of the most important aspects generated by manufacturing in lead–free technology is to assure the reliability at the level of classical lead technology as a result of many years of work and mass production.

Electronic packaging interconnections hierarchy can be organized on six levels:
Level 0: gate-to-gate interconnections on the chip; *Level 1:* chip-to-module connections; *Level 2:* board level interconnections; *Level 3:* board-to-board interconnections; *Level 4:* connections between sub-assemblies; *Level 5:* connections between systems (i.e., computer to printer).

The surface mounting assembling technology, typically for level 1 (Flip-chip technology) and 2 of electronic packaging hierarchy (Fig. 1), uses reflow soldering process.

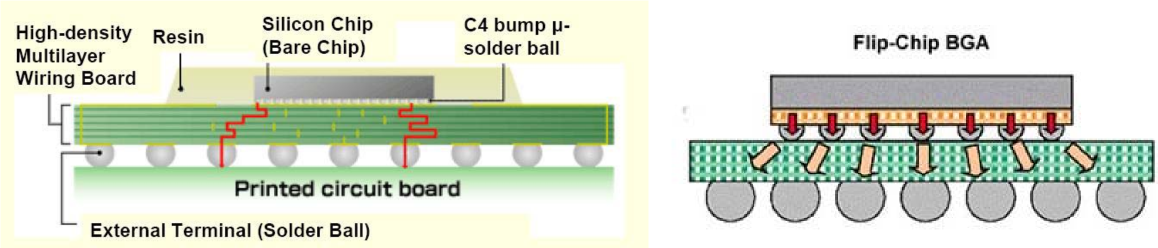


Fig.1. Electronic packaging interconnection hierarchy, level 1 and 2

The solder materials used at the level 1, the chip-level interconnects that join the chip to the lead frames, need to have melting point with minimum 50°C over soldering peak temperature at the level 2. After the lead-free roadmaps developed by JEIDA, the Japanese Electronics Industries Association (1998) and NEMI, the National Electronics Manufacturing Initiative (1999), in January 2003, The European Union published Directives 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) and 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE). These emerging directives have been the primary drivers for global movement toward lead-free electronics. The RoHS prohibits products that contain lead to be sold in the EU after July 2006, unless the use is specifically exempted. Pb-free solders recommended as the most promising candidates by the National Center for the Manufacturing Sciences (NCMS) and the National Electronics Manufacturing Initiative (NEMI) are Sn3.9Ag0.6Cu (+/- 0.2%) for reflow soldering and Sn0.7Cu for wave solder. This change to Pb-free solder creates new challenges in assembly and reliability evaluation of the flip-chip. Since, lead-free solders have higher melting points (217-221°C) then the traditional eutectic Sn/Pb solder (183°C) and hence they require higher reflow temperatures during assembly, soldering peak temperature can arise 235-260°C, depending on products (IPC/JEDEC J-STD-020C -July 2004). This can lead to higher thermo-mechanical stresses and strains leading to reliability issues like PWB warpage, delamination of interfaces, fracture and ask over 300°C for melting point of the solder materials used at the level 1. From other points of view, the special applications of the electronic equipments in automotive, aerospace, naval and military domains need high temperature solder material in order to assure functionality, quality and reliability in heavy work conditions, especially extreme work temperatures. As very well known, the functions of solder joints in electronic packaging are mechanical (high mechanical stress resistance), thermal (high thermal conductivity) and electrical (low electrical resistance). The functionality is in strong connection with the microstructure composition of the solder joints, which are the result of the soldering **P**rocess temperature gradient action over the trinomial solder alloy/**Paste**, electronic components terminals (**Pin**) and metallic substrate (**Pad**) on PCBs with different core materials (Aluminum, Copper, Ceramic, Glass, etc). The temperatures gradient is determined by the specific thermal profile of the soldering process. According to WG2 general objective (**The properties of solder joints**) the proposed GP project, **HISOLD 4P -Q&R**, takes into consideration idea that the new high temperatures solder materials will be used in the electronic assembling process and the scientific research programme emphasizes connection with the real conditions from soldering processes. The scientific programme (fig.2.) starts with 4P Soldering Model elements (Pad-Paste-Pin-Proces), existing information about macro and microstructural analysis, test requirements for solder joints functions and soldering processes models in order to realize experiment design, test vehicles and validations methods proof of concept. The test vehicles (PCBs) will be assembled using different soldering process and will be exposed to complex electrical mechanical, thermal, stress and tests. IPC standards and test methods will be used if applicable for the analyses of the solder joints, including thermodynamical, rheological and microstructural materials analyses; optical and SEM microscopy, X-Ray and XRF inspection; electrical functionality tests; nondestructive and destructive tests of the mechanical properties (e.g. shear and creep tests) with a special focus on nanoindentation and EBDS measurements; reliability prediction tests using accelerated stress methods, migration tests, whiskers formation analyses and others, if necessary.

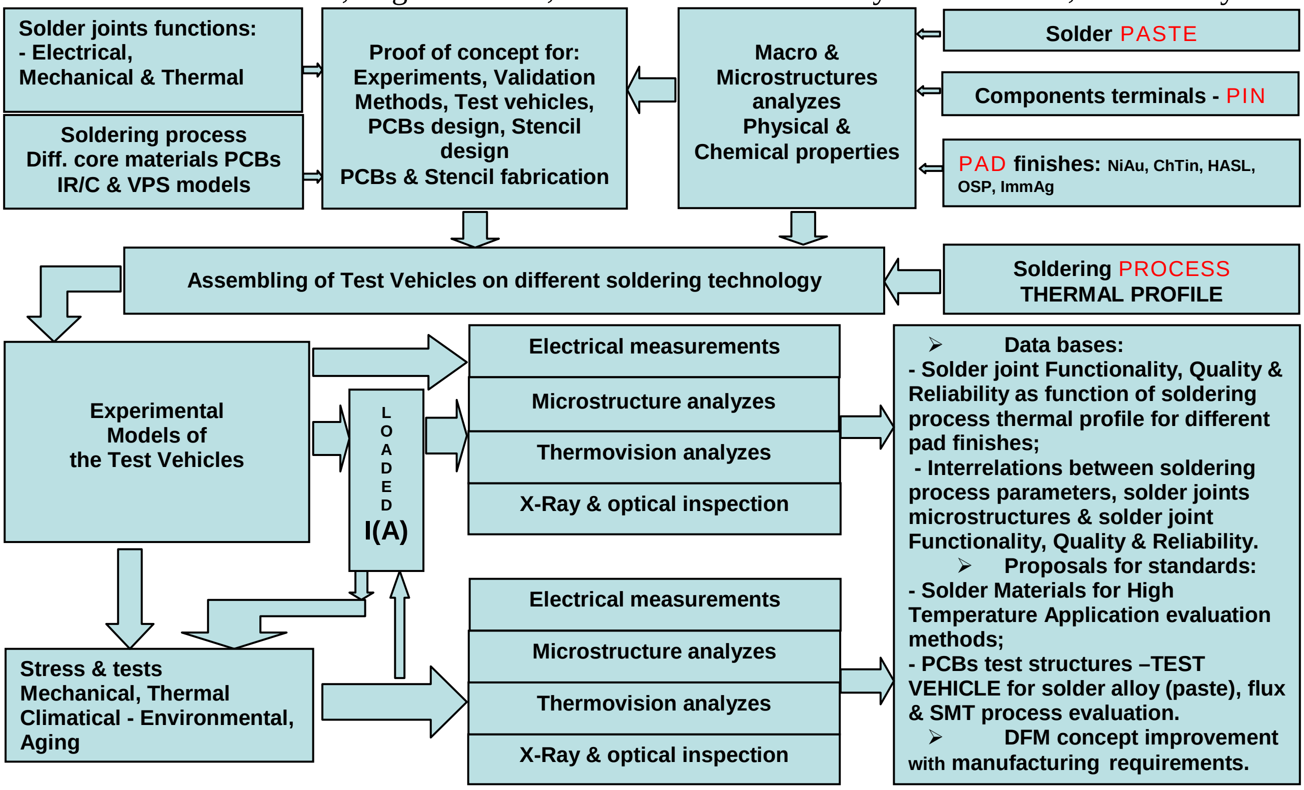


Fig.2. Scientific program of GP/WG2 research and experiments

Proper test vehicles will be defined to use the capabilities of the applied test methods. Simulations will be used for the validation of the experimental results. Standardized test methods and test vehicles will be proposed, and searchable data bases will be elaborated to provide easy access to the result of the studies, investigations and analyses. Finally, as a consequence, design rules and practical manufacturing recommendations will be defined to promote the application of the DFM concept.

The scientific program of GP/WG2 research and experiments responds to the challenge of flip-chip technology development.

Technology Node years	2005	2008	2011	2016
Number of I/Os	3158	4437	6234	8758
Flip-chip pitch (µm)	130	90	80	70
Pad Size (µm)	65	45	40	35

Tab.1. Projection of key features of microsystems packages [*Source: ITRS*]

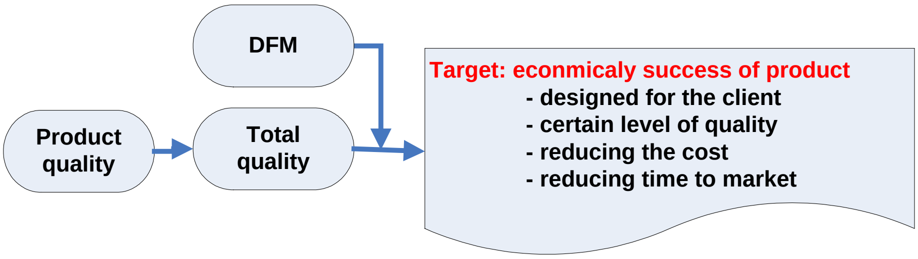
The flip-chip in lead-free technology can achieve a far greater number of I/O than any of the currently available options, still increasing functionality and decreasing consumer electronic sizes demand for ever increasing I/O’s. Table 1 shows the ITRS (International Technology Roadmap for Semiconductors) projection to meet the requirements of increased functionality and higher speed integrated into a smaller volume. ICs are projected to push to nano-scale lithography (35 nm by 2014) and the number of I/Os are projected to cross 10,000 I/Os with a required pitch (distance between two solder bumps) of 30 to 70 µm.

The scientific program of GP/WG2 research and experiments asks access to large scientific and technological resources, collaborative work, and multidisciplinary activities in interrelated stages.

3.3 Practical value of the project (approx. ½ page)

3.3.1 Indicate the practical problems which the study will address.

- Data base for normal, low and high temperature solder materials necessary in OEM/EMS companies to resolve the temperatures conflict between levels 1 and 2 of electronic packaging.
- Standard methods and test vehicles for solder alloy (paste), flux and SMT process evaluation for the producers and especially for the OEM/EMS companies with important consequences for increasing productivity, quality and reducing assembling costs. The European OEM/EMS companies should be able to use the same European standard methods and test vehicles to evaluate solder materials and assembling processes on European electronic products assembling market.;
- At the moment in the majority of OEM/EMS companies the assembling line parameters are adjusted by using optical and X-ray inspections. The consequences of the effect of soldering process thermal profile over solder joints microstructures as well as the functionality, quality and reliability of the solder joints are not taken into considerations. The data bases, result of **4 P Soldering Model** for solder joints quality assessment, with the recommended characterization and test results of functionality, quality and reliability of the solder joints as function of the HISOLD materials soldering on different pad finishes for different soldering process parameters as 4P Soldering Model elements will help to find the best solution;



Tab.2. DFM and Total quality concept actions

- The OEM/EMS companies apply the total quality concept (Tab.2) in order to maximizing the profit margin and for that reason the use of the DfM (Design for Manufacturing) concept became obligatory. The project will offer manufacturing requirements to improve conditions for DFM concept developing.

3.3.2 Indicate, if possible, the economic benefit expected from the research.

The project offer solutions in order to increase the functionality, quality and reliability of solder joints having as effect reduction of defections number on process and after final assembling of the products with important economic benefit taking into consideration rule of ten for malfunction level cost (Tab.3);

Malfunction level	Cost
Component	x
Part/ on process	10 x
Final assembling	100 x
Sale	1000 x
Customer	10000 x

Tab.3. Rule of ten for malfunction level cost

Data bases and evaluation methods created by project offer conditions to reduce production cost by reducing consumptions and optimizing cost/benefit ratio;

DFM concept (Tab.2) using project information offer possibility to obtain important economic benefit by optimizing manufacturing process, eliminate assembling defects on line and reducing time to market for the new products.

Sections 3.4.x - 3.5.x have to be filled in for each participating member!

3.4 Plan of research (approx. 1 page)

Participant 1: Paul Svasta / Ioan Plotog,

3.4.1. Description of the approach applied in the study

Our contribution consists of a study for solder joints functions measurement techniques; Soldering and assembling process models, parameters and thermodynamic properties; **4 P Soldering Model** for solder joints quality assessment: properties and typically parameters measurement techniques; Electronic component on PCBs, Mechanical stress models; Solder materials/Paste rheology, thermodynamic properties, microstructural analyses; PCBs climatic and mechanical stress model; Specifications for validation methods, test vehicles, stencils; Proof of concept for validation methods, test vehicles, stencils and experiments design; Test vehicles fabrication, 4P Soldering Model experiments necessary parts, solder materials and electronic components purchasing; Assembling processes; Joints functions measurements, microstructure and thermovizion analyses; Mechanical stress, thermal fatigue, aging; Data bases collection; Manufacturing requirement collection.

3.4.2. Outline of work plan and time schedule

WP	**P1** Workpackage description	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme	■	■	■	■	■	■	■	■	■	■	■	■	**P1**
2	**Definition of the materials of the 4P Soldering Model (paste-pad-pin-process)** structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Pow der alloy & flux for paste. Typically parameters, chemichal, mechanichal & thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305.	■	■	■	■	■	■	■	■					**P2**
3	**Mechanical & climatic stress models for PCBs and electronic components on PCBs.** Solutions for test methods and experiments Definition and application of the suitable simulation tools.	■	■	■	■	■	■	■	■					**P6**
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.			■	■	■	■	■	■					**P3**
5	**Soldering & assembling process models,** parameters & thermodynamic properties. Characteristically thermal profile for different soldering processes and cooling rate importance. Recommendation of processing methods and sites and coordinate the logistics and the actions of processing (assembling and soldering of the test vehicles)			■	■	■	■	■	■	■				**P1**
6	**Tests vehicles: Mechanical stress, thermal fatigue, aging tests**			■	■	■	■	■	■	■	■			**P6**
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation							■	■	■	■	■		**P4**
8	**DFM concept applications.** Definition of design rules and recommendations for best manufacturing practices.			■	■	■	■	■	■	■	■	■	■	**P1**

3.4.3. Staff required:1x Professor, 2x PhD student, 2x researchers, 1x technician

Participant 2. Jürgen Villain

3.4.1. Description of the approach applied in the study

P2 contribution consists of definition of the materials of the 4P (paste-pad-pin-process) structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Powder alloy and flux for paste. Typically parameters, chemical, mechanical and thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305

3.4.3. Outline of work plan and time

WP	**P2** Workpackage description	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme													P1
2	**Definition of the materials of the 4P Soldering Model (paste-pad-pin-process)** structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Powder alloy & flux for paste. Typically parameters, chemichal, mechanichal & thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305.													P2
3	**Mechanical & climatic stress models for PCBs and electronic components on PCBs.** Solutions for test methods and experiments Definition and application of the suitable simulation tools.													P6
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.													P3
5	**Soldering & assembling process models,** parameters & thermodynamic properties. Characteristically thermal profile for different soldering processes and cooling rate importance. Recommendation of processing methods and sites and coordinate the logistics and the actions of processing (assembling and soldering of the test vehicles)													P1
6	**Tests vehicles: Mechanical stress, thermal fatigue, aging tests**													P6
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation													P4
8	**DFM concept applications.** Definition of design rules and recommendations for best manufacturing practices.													P1

3.4.3. Staff required:

Participant 3. Gábor Harsányi / Zsolt Illyefalvi-Vitez

3.4.1. Description of the approach applied in the study

P3 contribution consists of definition and design of the test vehicles, solder joints electrical, mechanical, thermal functions measurement techniques and methods. Tests vehicles experiments: mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques and experiments design. Wickers studies and experiments design proposal.

3.4.2. Outline of work plan and time

WP	P3 Workpackage description	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme													P1
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.													P3
5	**Soldering & assembling process models,** parameters & thermodynamic properties. Characteristically thermal profile for different soldering processes and cooling rate importance. Recommendation of processing methods and sites and coordinate the logistics and the actions of processing (assembling and soldering of the test vehicles)													P1
6	**Tests vehicles: Mechanical stress, thermal fatigue, aging tests**													P6
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation													P4
8	**DFM concept applications.** Definition of design rules and recommendations for best manufacturing practices.													P1

3.4.3. Staff required: 2x Professor, 3x PhD student, 2x researchers, 2x technician

Participant 4. Mihai Branzei / Florin Miculescu

3.4.1. Description of the approach applied in the study

P5 contribution consists of a study for soldering and assembling process models, parameters and thermodynamic properties; SnZn + Al + X / SAC +Ni + X solder material type realized, typically parameters, chemical and thermodynamic properties; 4P Model: properties and typically parameters measurement techniques; Solder materials/Paste thermodynamic properties, microstructural analyses; Specifications for validation methods, test vehicles; Proof of concept for validation methods, test vehicles and experiments design; Joints functions microstructure analyses; Data bases collection.

3.4.2. Outline of work plan and time

WP	**P4** Workpackage description	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme	■	■	■	■	■	■	■	■	■	■	■	■	P1
2	**Definition of the materials of the 4P Soldering Model (paste-pad-pin-process)** structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Powder alloy & flux for paste. Typically parameters, chemichal, mechanichal & thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305.	■	■	■	■	■	■	■	■					P2
3	**Mechanical & climatic stress models for PCBs and electronic components on PCBs.** Solutions for test methods and experiments Definition and application of the suitable simulation tools.	■	■	■	■	■	■	■	■					P6
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.			■	■	■	■	■	■					P3
5	**Soldering & assembling process models,** parameters & thermodynamic properties. Characteristically thermal profile for different soldering processes and cooling rate importance. Recommendation of processing methods and sites and coordinate the logistics and the actions of processing (assembling and soldering of the test vehicles)			■	■	■	■	■	■	■				P1
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation							■	■	■	■	■		P4

3.4.3. Staff required: 1x Assoc. Prof., 1x Lecturer, 1x Assistant, 1x Researcher

Participant 5. Alena Pietrikova

3.4.1. Description of the approach applied in the study

P6 contribution consists of a study for joints functions measurement techniques; Soldering and assembling process models, parameters and thermodynamic properties; 4P Model: properties and typically parameters measurement techniques; Electronic component on PCBs, Mechanical stress models; Solder materials/Paste rheology, thermodynamic properties, microstructural analyses; PCBs climatic and mechanical stress model; Specifications for validation methods, test vehicles, stencils; Proof of concept for validation methods, test vehicles, stencils and experiments design; Test vehicles fabrication, 4P model parts, solder materials and electronic components purchasing; Assembling processes; Joints functions measurements, microstructure and thermovizion analyses; Mechanical stress, thermal fatigue, aging; Data bases collection; Manufacturing requirement collection.

3.4.4. Outline of work plan and time

WP	**P5** **Workpackage description**	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme	■	■	■	■	■	■	■	■	■	■	■	■	P1
2	**Definition of the materials of the 4P Soldering Model (paste-pad-pin-process)** structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Powder alloy & flux for paste. Typically parameters, chemichal, mechanichal & thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305.	■	■	■	■	■	■	■	■					P2
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.			■	■	■	■	■	■					P3
5	**Soldering & assembling process models,** parameters & thermodynamic properties. Characteristically thermal profile for different soldering processes and cooling rate importance. Recommendation of processing methods and sites and coordinate the logistics and the actions of processing (assembling and soldering of the test vehicles)			■	■	■	■	■	■	■				P1
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation							■	■	■	■	■		P4
8	**DFM concept applications.** Definition of design rules and recommendations for best manufacturing practices.			■	■	■	■	■	■	■	■	■	■	P1

3.4.3. Staff required: 1x Professor, 2x PhD students, 4x researchers, 2x technicians.

Participant 6. Dan Mihai Constantinescu

3.4.1. Description of the approach applied in the study

P7 contribution consists of a study for SnZn + Al + X / SAC +Ni + X solder material type realized, typical parameters, mechanical properties; Electronic component on PCBs mechanical stress models; PCBs mechanical stress model; Specifications for validation methods, test vehicles, experiments design; Mechanical stress, facture mechanics experiments; Data bases collection.

3.4.2. Outline of work plan and time

WP	**P6** Workpackage description	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme													P1
3	**Mechanical & climatic stress models for PCBs and electronic components on PCBs.** Solutions for test methods and experiments Definition and application of the suitable simulation tools.													P6
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.													P3
6	**Tests vehicles: Mechanical stress, thermal fatigue, aging tests**													P6
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation													P4

3.4.3. Staff required: 1x Professor, 2xAssoc. Prof., 2x PhD students, 2x researchers.

Participant 7. Corneliu Balan

3.4.1. Description of the approach applied in the study

P8 contribution consists of a study for Soldering and assembling process models, parameters and thermodynamic properties; SnZn + Al + X / SAC +Ni + X solder material typically parameters, chemichal and thermodynamic properties; Solder materials/Paste rheology, thermodynamic properties; Specifications for validation methods, test vehicles,experiments design; Data bases collection.

3.4.2. Outline of work plan and time

WP	**P7** Workpackage description	2008		2009				2010				2011		WP leader
		3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recomme													P1
2	**Definition of the materials of the 4P Soldering Model (paste-pad-pin-process)** structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Powder alloy & flux for paste. Typically parameters, chemichal, mechanichal & thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305.													P2
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.													P3
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation													P4

3.4.3. Staff required: 1x Prof., 1xPhd student.

3.5. Experience and Resources of the Institutions

Brief summary of previous or current work in similar or related fields. Publications in the last two years. Staff and equipment available at the laboratory for the efficient execution of the proposed research work.

3.5.1. Participant 1: Paul Svasta / Ioan Plotog

The Centre for Technological Electronics and Interconnection Techniques (UPB-CETTI) was founded in 1995 as research centre integrated in "Politehnica" University of Bucharest. It is ISO-9001 certificate since 2004 and IPC member since 1997. CETTI has as target the technological electronic ant interconnections techniques at the printed layer level (PCB): CAD-CAE-CAM and DFM designing, modeling and simulation, assembling, measurements and quality analysis. Has in structure an entity specialized in technological transfer and electronic assembling technology: Technological and Business Incubator CETTI-ITA. In present is implicated in national and European research programs, LEONARDO, FP7 COST projects, bilaterally with Hungary and Slovakia, being now a well known electronic packaging centre and having cooperation with a series of national and European universities and organizations. The topics of recent studies are lead-free solder materials, lead-free SMT soldering process, 4P Soldering Model solder joints quality assessment, solder joints properties and lead free solder joints quality, functionality and reliability as function of high temperature solder materials, soldered on different pad finishes for different soldering process parameters.

Some of the publications in the last two years regarding the works in the project field:

1. **Multi-criterial Approach for Implementing of Lead-free Technology**, I. Plotog, S. Jianu, C. Turcu, T. C. Cucu, N.D.Codreanu, 4th European Microelectronics and Packaging Symposium, May 21-24, 2006, Terme Catez, Slovenia, pp. 301-306.
2. **DFM Concept for Wave Soldering Technology** - I. Plotog, S. Jianu, C. Turcu, A. Stan, T.C.Cucu, N.D.Codreanu la SIITME 2006, International Symposium for Design and Technology of Electronic Packaging, Iasi, Conference proceedings; pag. 85-89, 2006;

3. **The Lead-Free Solder Paste Characteristics, DFM Concept and New Aspects Regarding Reflow Process** - P.Svasta, I.Plotog ,T.C. Cucu, The 5-th Conference "NEW RESEARCH TRENDS IN MATERIAL SCIENCE", ARM-5, SIBIU 2007, Romania , Vol. I, pag.79-84
4. **Low-Silver SAC Alloy as an Alternative to SAC Alloys** - P.Svasta, T.C. Cucu, I.Plotog in The 5-th Conference "NEW RESEARCH TRENDS IN MATERIAL SCIENCE", ARM-5, Proceedings, Volume III, pag.848-851
5. **Implementation of Ecological Technologies in Electronic Industry based on RESPLATEPE Research project**- N.D.Codreanu, I.Plotog, P.Svasta, C.Turcu, G.Varzaru, D.Pitica, M.Gavan, A.Bara, C.Farcas, Al.Marin, T.C.Cucu in ISSE 2007, 30th International Spring Seminar on Electronics Technology, Proceedings, pag.263-268
6. **DFM Solutions for Tombstoning in Vapour Phase Soldering Technology** – I.Plotog, G.Varzaru, C.Turcu, T.C.Cucu, N.D.Codreanu in SIITME 2007, International Symposium for Design and Technology of Electronic Packaging, Conference proceedings, pag.226-230
7. **Investigations on Assembling of Electronic Packages onto Glass Substrates using Lead-free Technology,** Ioan Plotog, Norocel Codreanu, Paul Svasta, Traian Cucu, Carmen Turcu, Gaudenţiu Vărzaru, Gheorghe Lazăr, Alexandru Bătucă**,** ISSE 2008, 31st International Spring Seminar on Electronics Technology Reliability and Life-time Prediction, 7-11 May, 2008, Budapest, Hungary
8. **The Microstructure of Lead-Free Solder Joints on Different Metallic Substrates as Function of Soldering Thermal Profile and Consequences Over Electrical Parameters**, I. Plotog, M. Branzei, D. Gheorghe, G. Varzaru, T.C. Cucu, P. Svasta, C. Turcu, TOFA 2008, The Discussion Meeting on Thermodynamics of Alloys, Krakow June 22 - 27, 2008
9. **Pin-In-Paste DFM Constraints in Vapor Phase Soldering Technology for Optoelectronic Components**, I. Plotog, G. Varzaru, C. Turcu, T. C. Cucu, P. Svasta, A. Vasile, ATOM-N 2008, The 4th Advanced Topics in Optoelectronics, Microelectronics and Nanotechnologies Conference, 29 - 31 August 2008, Constanta, Romania
10. **VPS Solution for Lead-Free Soldering in EMS Industries,** Ioan Plotog, Gaudentiu Varzaru, Carmen Turcu, Traian Cornel Cucu1, Paul Svasta, Norocel Dragos Codreanu, ESTC 2008, 2nd Electronic Systems-Integration Conference, 1-4 September, Greenwich.
11. **The Reflow Soldering Thermal Profile and Consequences over Functionality of Lead-Free Solder Joints**, I. Plotog, G. Varzaru, T.C. Cucu, P. Svasta, C. Turcu, SIITME 2008, 18-21 Septembrie 2008 Brasov-Predeal, Romania

CETTI is disposing of:

- SMT technological equipments, mechanical and climatic testing, software, technical endowment and expertise for electrical parameters measurement, design, modeling and simulations CADENCE-ORCAD, VisualCAM, CircuitCAM, OMEGA PLUS, EMC Advisor, Zeland IE3D and FIDELITY, ANSYS, MATLAB;
- Thermovision (NETD<0.06^{o}C) and FLOTHERM / BETASOFT thermal management and modeling tools;
- VNA (Vector Network Analyzer) and TDR (Time Domain Reflectometry) equipment.

The equipment available at the CETTI laboratory for the efficient execution of the proposed research work are: - PCB fabrication equipment LPKF Protomat M100 – HF; - Automatic dispensing equipment ASYMTEC A-6126; - Manual stencil printing, Zelprint; - Automatic stencil printing DEK260; - Manual Pick and Place DIMA SMFL3000; - Automatic Pick and Place SAMSUNG CP20CV; - Soldering stations Weller PU81, SGS-2505; - SMT oven Zephir SMRO-0252, PICCOLO DIMA-054; - Thermal data acquisition system THERMES (16 channels); - Optical inspection DIMA VC 3011, Miscope Pulsar MV40; - Repair and Rework equipment PACE, PDR X410; - Climatic chamber ESPEC SH-241; - Thermo-stated drying oven up to 300 ºC CALORIS; - Thermovision camera SC640-FLIR SYSTEM; - RF Network/Spectrum/Impedance Analyzer HP 4396B.

CETTI staff allocated for the project: 1x professor, 2 associate professors, 2x PhD student, 2x researchers, 1 x technician

3.5.2. Participant 2. Jürgen Villain

Some of publications in the last 2 years:

The equipments available in the BME-ETT laboratories for completion of the proposed research are: Soldering technology for laboratory experiments, LINKAM LTS350, CI94, LNP equipments, shear test equipment type Condor 70-3, XYZTEC, Laserextensiometer type parallelscaner P50, Zwick Company completed with videocamera, thermal shock chamber type ESPEC, SEM (Scanning Electron Microscopy), EDS (Energy Dispersive Spectroscopy) and EBSD (Electron BackScattered Diffraction) completed with Nanoindentation, VPS equipment.

3.5.3. Participant 3. Gábor Harsányi / Zsolt Illyefalvi-Vitez

Some of publications in the last 2 years:

1. **Selective laser soldering on flexible boards using through foil heating,** Zsolt Barnyay, Zsolt Illyefalvi-Vitéz, Bálint Balogh, ISSE 2008 – 31st International Spring Seminar on Electronics Technology, 7-11 May, 2008, Budapest, Hungary pp.437-442.
2. **Life-Time Test of Laser and Reflow Soldered Flexible Substrates** Réka Bátorfi, Zsolt Illyefalvi-Vitéz:, ISSE 2008 – 31st International Spring Seminar on Electronics Technology, 7-11 May, 2008, Budapest, Hungary, pp.61-66.
3. **New reliability test regimes to investigate components self-alignment effect,** Zsolt Illyefalvi-Vitéz, Olivér Krammer, János Pinkola, Réka Bátorfi, Seminar "Electronics Packaging for Ecology", 25-27 July, 2008, Sinaia, Romania.
4. **Investigating the Movement of Chip Components during Reflow Soldering,** Olivér Krammer, Zoltán Radvánszki, Zsolt Illyefalvi-Vitéz, ESTC 2008 – 2nd Electronics Systemintegration Technology Conference, 1-4 Sep, 2008, Greenwich, UK, pp.851-856.
5. **Life-time Test of Laser Soldered Joints on Flexible Boards,** Zsolt Illyefalvi-Vitéz, Bálint Balogh, Zsolt Baranyay, Réka Bátorfi, Graham Farmer, ESTC 2008 – 2nd Electronics Systemintegration Technology Conference, 1-4 Sep, 2008, Greenwich, UK, pp.877-883.
6. **Investigating the Shear Strength of Chip Component Solder Joints,** Olivér Krammer, Zsolt Illyefalvi-Vitéz, SIITME 2008 – 14th International Symposium for Design and Technology of Electronic Packages Edition, 18-21 Sep, 2008, Predeal, Romania, pp. 301-305.

The equipments available in the BME-ETT laboratories for completion of the proposed research are: Multilayer PWB laboratory, shear tests equipments, Thermal Shock Chamber, Temperature and Humidity Chamber Dage XiDat 6600 - X-ray inspection system, Veeco AFM - atomic force microscope, Sonix HS 1000 SAM - scanning acoustic microscope, Spectro MidexM XRF - X-ray fluorescent spectrometer, Alpha-Step 500 laser scans, Coherent Avia UV Nd:YAG laser, Synrad CO2 laser processing system, Olympus microscope, 50-1000x magnification, Struers Knuth-Rotor-3 wet grinder.

3.5.4. Participant 4. Mihai Branzei / Florin Miculescu

Some of publications in the last 2 years:

1. **"Thermal Diffusivity of Materials Using Flash Method Applied on Co-Cr Alloys**"; **M.Branzei**, M.Miculescu, G.Cosmeleata, **F.Miculescu**; Univ. POLITEHNICA of Bucharest, SCIENTIFIC BULLETIN, Series B: Chemistry and Materials Science, Volume 70 / 2008 / Number 2 (ISSN 1454-2331);
2. **"A Proposal for Initial Material Characterization of Gauge Blocks Dimensional Stability in Time"**; **M.Branzei,** M.Miculescu, D.Gheorghe, **F.Miculescu**; ITCC29 and ITES17 Conference, Birmingham-Alabama, USA 2007;

3. **“Characterization of Some High Dispersed and Conductive Metallic Powders for Integrated in Polymeric Coatings”**; **M.Branzei**, A.Bantas, D.Gheorghe, M.Miculescu, **F.Miculescu**; ITCC29 and ITES17 Conference, Birmingham-Alabama, USA 2007;
4. **“Thermal Barrier Effect of Refractory “EV”-Enamel”; M.Branzei**, I.Pencea, D.Stroe Gaal, **F.Miculescu**, D.Gneorghe; 17th ECTP, Bratislava-Slovakia, 2005 (ISBN: 80-8050-874-7).

Laboratory of Thermophysical Properties:

A. UNITHERMTM MODEL 1161V High Temperature Dilatometer: Temperature to 1700C - Absolute digital transducer - Dual sample/differential operation - Fully automated WindowsTM based - Controlled-rate sintering - Vacuum/inert gas purge/ H2 atmosphere;
B. FLASHLINETM 3000 Thermal Diffusivity System: Operating ranges from cryogenic to 1000C - Large sample size for coarse-grain materials - Fast test times and high throughput - Multiple sample capability - Specific heat determination - Thermal conductivity measurement.

Laboratory of Qualitative and Quantitative Microscopy:

A. Automatic Sample Preparation System: DELTA AbrasiMet Cutting Machine – ISOMET 4000, Linear Precision Saw - SIMPLIMET 1000 Hot Mounting Press, VACUUM-SET-UNIVERSAL, for cold mounting samples – ALPHA, BETA & VECTOR, Grinder/Polisher and Power Head;
B. Quantitative Image Analyzer System: REICHERT UnivaR microscop – BUEHLER OMNIMET ENTERPRISE Software, for Materialography.

Laboratory of Electronic Microscopy (ESEM):

XL-30-ESEM TMP electronic microscope, with EDAX analyzer, stage peltier, system control software packet and equipment analysis.

3.5.5. Participant 5. Alena Pietrikova

Some of publications in the last 2 years:

1. **Microstructural analysis and transport properties of RuO2-based thick film resistors**, GABÁNI, S. , FLACHBART, K. , PAVLÍK, V. , PIETRIKOVÁ, A. GABÁNIOVÁ, M.: / In: Acta Physica Polonica A. - ISSN 1898-794X. - Vol. 113, no. 1 (2008), p. 625-628.
2. **Microstructure analysis and measurement of nonlinearity of vapour phase reflowed solder joints**, PIETRIKOVÁ, A. - ĎURIŠIN, J. - LIVOVSKÝ, Ľ.- URBANČÍK, J.: / In: ISSE 2008 : 31st International Spring Seminar on Electronics Technology. - P. 365-368. - Budapest : Budapest University of Technology and Economics, Department of Electronics Technology, 2008. - http://www.isse-eu.net - ISBN 978-963-06-4915-5.
3. **Monitoring of the temperature profile of vapour phase reflow soldering,** LIVOVSKÝ, Ľ., PIETRIKOVÁ, A. - ĎURIŠIN, J.: / In: ISSE 2008 : 31st International Spring Seminar on Electronics Technology. - P. 687-689. - Budapest: Budapest University of Technology and Economics, Department of Electronics Technology, 2008. - http://www.isse-eu.net - ISBN 978-963-06-4915-5.
4. **Microstructure of vapour phase reflowed SAC solder alloy,** PIETRIKOVÁ, A. - ĎURIŠIN, J.: In: Materiál v inžinierskej praxi 2008 : Zborník 7. medzinárodnej vedecko-technickej konferencie. - S. 23-26. - Košice : TU, 2008. - ISBN 978-80-8073-945-4.
5. **E-Learning Training System for Electronics Assembling Technology,** Zsolt Illyefalvi-Vitéz, Svasta, P., Codreanu, N., Pietrikova, A.**,** International Symposium for Design and Technology of Electronic Packages, SIITME, 14th Edition, Brasov, Romania, ISSN 1843-5122, pp. 356 – 361
6. **Microstructure evolution of Vapour Phase Reflowed tinsilver Copper Alloy,** PIETRIKOVÁ, A. - ĎURIŠIN, J.:, International Conference on Applied Electrical

Engineering and Informatics 2008, AEI 2008, Greece, Athens ISBN: 978-80-553-0066-5 © 2008, pp. 83-86

7. **Measurement of nonlinearity of lead-free vapour phase reflowed solder Joints,** PIETRIKOVÁ, Alena - BANSKÝ, Juraj - ĎURIŠIN, Juraj, In: Acta Electrotechnica et Informatica. roč. 7, č. 3 (2007), s. 9-12. ISSN 1335-8243.
8. **Optimization of testing methods for investigation of joints quality based on vapour phase lead-free soldering,** ĎURIŠIN, Juraj - PIETRIKOVÁ, Alena - LIVOVSKÝ, Ľubomír:. In: ISSE 2007 : 30th International Spring Seminar on Electronics Technology : Emerging Technologies for Electronics Packaging : May 9 - 13, 2007, Cluj-Napoca, Romania. S.l. : IEEE, 2007. p. 258-262. ISBN 1-4244-1218-8.

The research team consists of 11 scientific co-workers of Department of Technologies in Electronics FEI TU of Košice. The existing infrastructure: PCB preparation and metallic masks – etching apparatus – own apparatus, - stencil printer, - CNC drilling machine for PCB production, - Preparation of experimental samples – own VPS equipment, - Viskozimeter Haake, - Complete experimental equipment for realising thick film technology, - comparison with standard reflows process - modern 11 zone reflow oven, - Structural analysis – X-ray diffract meter Philips X'Pert, - Structural analysis – Electron microscopy - JEOL JSM 7000F, - Measurement of the mechanical properties – universal equipment for static pull and pressure tests, - Electrical measurements – Mili- and micro ohmmeter.

3.5.6. Participant 6. Dan Mihai Constantinescu

1. **Evaluation of elastic and strength properties of soldering alloys with reduced content of lead** - Dan Mihai Constantinescu, Matei Constantin Miron, Nicolae Constantin, Mircea Gavan, *Ecological Electronic Packaging Seminar*, pag. 62-66, Sinaia, 25-27.07.2008

The equipments available in the CCMA laboratories for completion of the proposed research are:
-Static and fatigue testing machines (Lloyd Instruments, Walter + Bai, Instron - all with adequate software packages);
-Pendulum impact testing equipment
-Digital Image Correlation Method – ARAMIS and ARGUS systems;
-IR camera A 40 M
-Software for NDT infrared testing, NASTRAN+MSN.FATIGUE, COSMOS M+SOLIDWORKS

3.5.7. Participant 7. Corneliu Balan

Some of publications in the last 2 years:

1. **Onset of the rheological fluid behavior in high concentrated suspensions,** Kadar R., Balan C., in the XVth Int. Congress Rheology – Monterey Aug. 2008, Edit. by Co A., Leal I.G., Colby R.H. and Giacomin A.J., 815-817.
2. **A new approach to determine the nonlinear parameter of the Giesekus constitutive model,** Calin A., Balan C., Wilhelm M., in the XVth Int. Congress Rheology – Monterey Aug. 2008, Edit. by Co A., Leal I.G., Colby R.H. and Giacomin A.J., 1372-1374.
3. **Investigations of vertical structures in bifurcations,** Broboana D., Bernad S., Balan C., in the XVth Int. Congress Rheology – Monterey Aug. 2008, Edit. by Co A., Leal I.G., Colby R.H. and Giacomin A.J., 291-293.
4. **Experimental and numerical studies of weakly elastic viscous fluids in a Hele-Shaw geometry,** Broboană D., Muntean T., Balan C., Proc.of the Romanian Academy, Series A, Mathematics, Physics, Technical Science, Information Science, Vol. 8, No. 3, 2007

5. **Investigation of vortices existence at the interface between immiscible fluids,** Broboana, D., Calin, A., Balan, C. in CMFF'06, Budapest, Hungary, September 6 – 9, 2006, Ed. by Lajos T. and Vad J., pp. 806 – 813 (ISBN 963 420 872 X)
6. **A finite deformation formulation of the 3-parameter viscoelastic fluid,** Balan, C., Tsakmakis, Ch., J. Non-Newtonian Fluid Mech. (ISSN 0377-0257) 103(1), 45 – 64, 2002 (JRK0.87/JIF1.31)
7. **Experimental and numerical investigations on the pure material instability of an Oldroyd's 3-constant model**, Balan, C. Continuum. Mech. Thermodyn. (ISSN 0935-1175) 13, 399 – 414, 2001(JRK0.85/JIF0.64)
8. **Rheology of Solder Pastes: Procedure to Determine the Yield Shear Stress,** Balan, C., D. Broboana, R. Kadar, RESPLATEPE project Proceedings, REOROM Laboratory, Hydraulics Department, Politehnica University, Bucharest, Romania 2008

The research is performed in two "sister" laboratories (same location): REOROM Laboratory and "Field-Matter Interaction "Laboratory (BIOINGTEH Platform). The current work in REOROM laboratory is the experimental investigations, rheological modeling and numerical simulations of viscoelastic fluids. The focus of research is the modeling of complex fluids, in particular the fluids with yield shear stress, category in which the solder pastes (high concentrated suspensions) are included. The available equipment consists of: MC 301 Paar-Physica Rheometer in complete configuration (production 2007); Micro-Fourier Rheometer (production 2007); micro PIV system (production 2008); different optical devices for flow visualization; Squeezing Rheometer; Clean glove box under controlled atmosphere.
Staff: 1x Prof, 1 x Assoc. Prof, 2x PhD students

3.6. Co-operation (minimum of 3 partners in at least 2 countries, approx. 1 page)

Work plan, division of work among partners and time schedule (Tab. 4) will take into consideration as zero moment 2007 because some experiment and studies was already donned. The information will be exchange by the participant results also from 3.4. The workpackages are defined according to the main topics and methods of the cooperative research. Each workpackage will have a volunteer WP leader, who will collect the data regarding the WP topic and will coordinate the research actions in the WP. The WP leaders will be appointed and the exact schedule by filling up the timetable of Table 4 will be defined during the GP/WG2 KOM. For the beginning WP leaders are proposed there.

In all cases the tasks of the WP leader will include the collection of:

- the already available data and research results relevant to the WP topic, for the inclusion into the data bases;
- the materials, processes, test and simulation methods that are available at each partner's site and could be offered for use in the cooperative research;
- the types and extent of activities that each partner offers for the cooperative research;
- the new results continuously and uploading into the data bases;
- each partner's results, evaluations, comments, conclusions and recommendations, and inclusion all these results into a concise WP report.

Work packages and time schedule presented in Tab.4, has activities organized in the following classes that involve cooperation between partners from all work packages:

A. Modeling, simulation and collect data about: electrical, thermal, mechanical functions, measurement methods, properties, wickers aspects, microstructural analyzes, thermo-mechanical stress and tests methods for solder joints quality as **4 P Soldering Model** assessment; Soldering and assembling process models, parameters and thermodynamic properties; Characteristically thermal profile for different soldering processes and cooling rate importance: WP1, WP2 and WP3.

B. Specifications defined, Proof of concept for methods and techniques, test vehicles, stencils and experiments design based on A class results and tests vehicles fabrication: WP4.
C. HISOLD solder material (including HISOLD powder, paste and composite solder paste) proposed for studies: WP2.
D. Tests vehicles experiments: Mechanical stress, thermal fatigue, aging tests WP6.
E. Solder joints functions measurements, microstructure and thermovizion analyses, before and after mechanical stress, thermal fatigue, aging tests: WP7;
F. Data bases and DFM requirements collection: WP8.

The partner has also strong connection with economical environment, as examples: P1 with INTRAROM; P3 with FLEXTRONICS; P6 with ELCOM.

Tab. 4. Work plan and time schedule

WP	Workpackage description	Participants							2008		2009				2010				2011		WP leader
		1	2	3	4	5	6	7	3	4	1	2	3	4	1	2	3	4	1	2	
1	**GP/WG2 Project Management,** The data base structure definition, Design of Experiments, dissemination actions coordination, Coordination and control of the evaluation activities & Data bases collection, conclusions for standardized test vehicles, recommended test methods and simulation tools.																				P1
2	**Definition of the materials of the 4P Soldering Model (paste-pad-pin-process)** structures for the investigations: HISOLD solder material proposal for studies. (SnZn + Al + X / SAC +Ni + X / SAC305 + X) solder material type realized. Powder alloy & flux for paste. Typically parameters, chemichal, mechanichal & thermodynamic properties. X = nanoparticles or CNTs or SnZn-alloys for SAC 305																				P2
3	**Mechanical & climatic stress models for PCBs and electronic components on PCBs.** Solutions for test methods and experiments Definition and application of the suitable simulation tools.																				P6
4	**Definition and design of the test vehicles.** Solder joints electrical, mechanical, thermal functions measurement techniques and methods. Mechanical stress, thermal fatigue, aging tests. Properties, typically parameters measurement, microstructure analyzes techniques & experiments design. Wickers studies and experiments design proposal.																				P3
5	**Soldering & assembling process models,** parameters & thermodynamic properties. Characteristically thermal profile for different soldering processes and cooling rate importance. Recommendation of processing methods and sites and coordinate the logisticsand the actions of processing (assembling and soldering of the test vehicles)																				P1
6	**Tests vehicles: Mechanical stress, thermal fatigue, aging tests**																				P6
7	**Joints functions measurements**, microstructure & thermovizion analyses before& after mechanical stress, thermal fatigue, aging tests. Recommendation of test methods and sites for the experiments and coordinate the logistics and the actions of investigation																				P4
8	**DFM concept applications.** Definition of design rules and recommendations for best manufacturing practices.																				P1

2. SUBMISSION

Please submit the proposals by e-mail, in WORD and in English, addressed for the attention of:

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Annex 2

Contact Persons for Working Groups:

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