IMATPROJECT.EU

Figure 0 - Project LOGO

Participant no.	Name	Acronym	Country
1	University of Florence	UNIFI	Italy
2	Future Carbon	FC	Germany
3	Laura Amorosi Restauro	LAR	Italy
4	Stichting Restauratie Atelier Limburg	SRAL	The Netherlands
5	Lorenzo Conti	LC	Italy
6	Nardini Editore	NE	Italy
7	C.T.S.	CTS	Italy
8	Sefar A.G.	SEFAR	Switzerland
9	Istituto per l'Arte e il Restauro	IAR	Italy
10	Pranas Gudynas Restoration Centre	PGLC	Lithuania
11	Tomas Markevicius	TM	The Netherlands

Figure 1 – IMAT Consortium

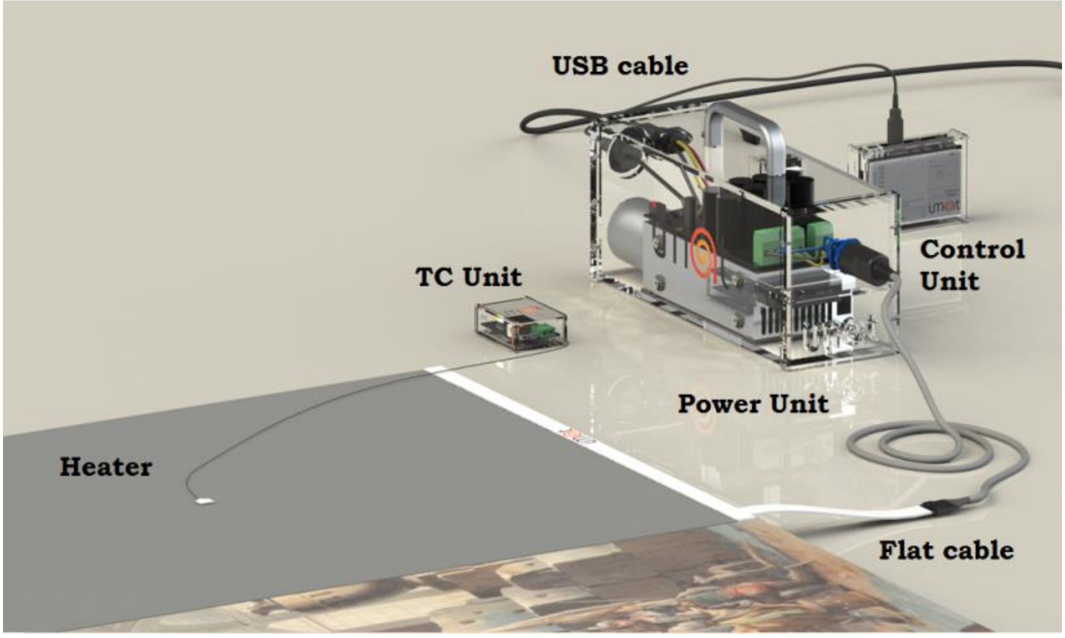

Figure 2 – IMAT final design

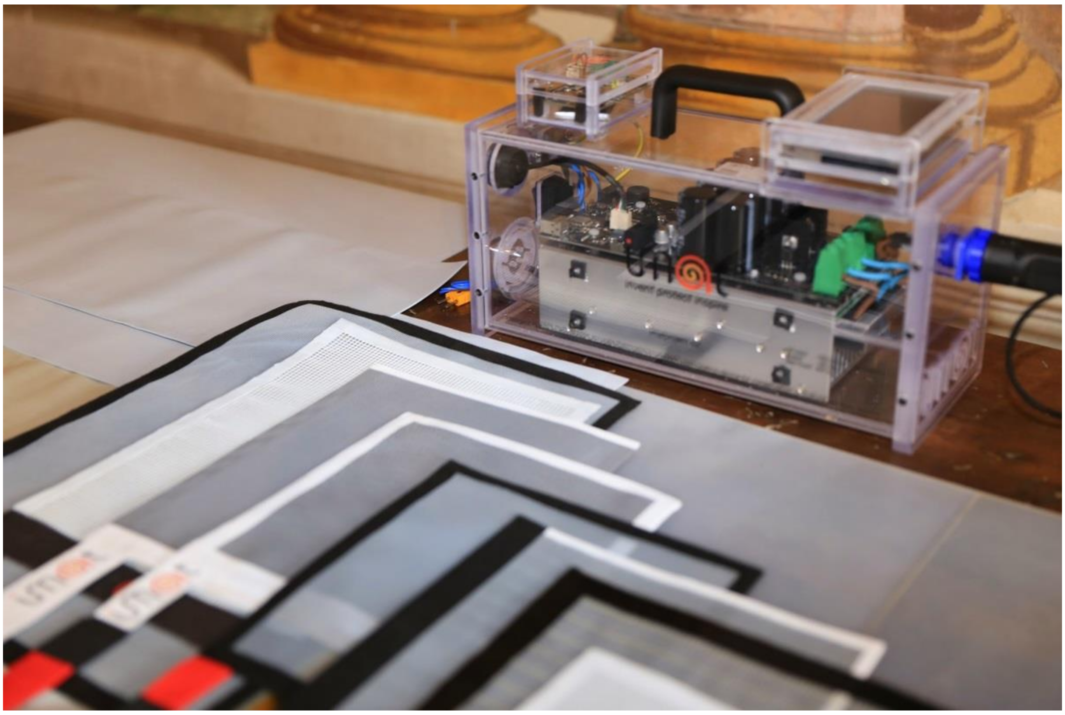

Figure 3 – IMAT prototypes

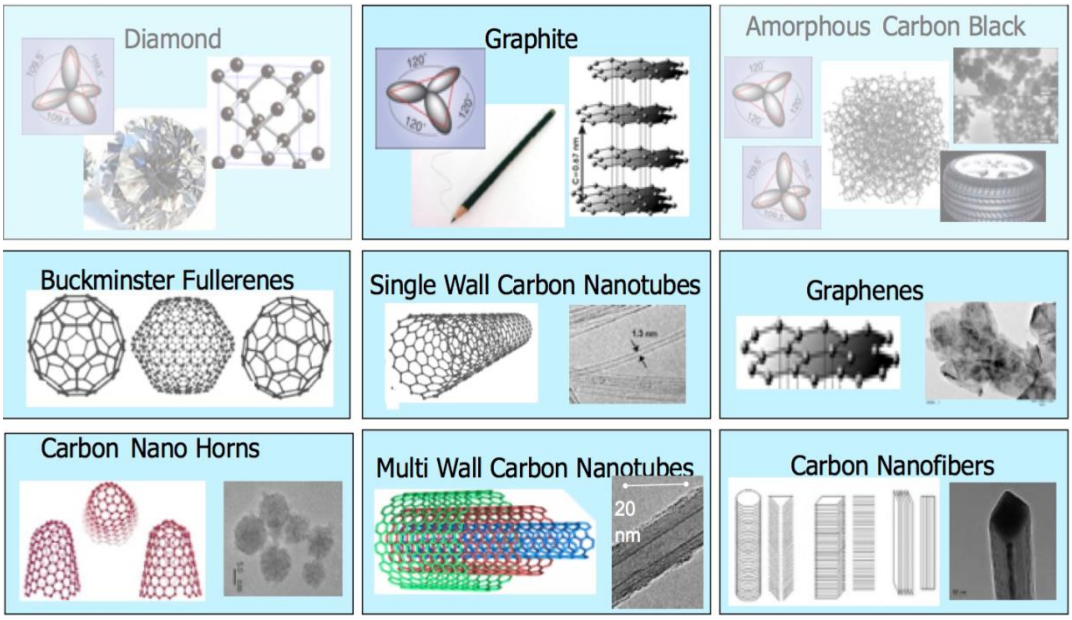

Figure 4 – Morphology of various kinds of nano carbons based on grapheme structures

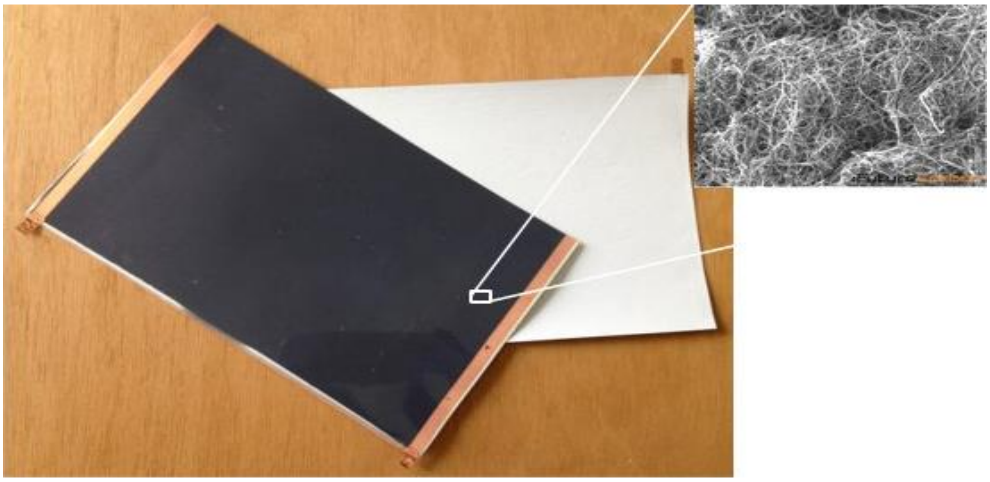

Figure 5 – CNT coating layer with billions of tiny highly entangled carbon nanotubes

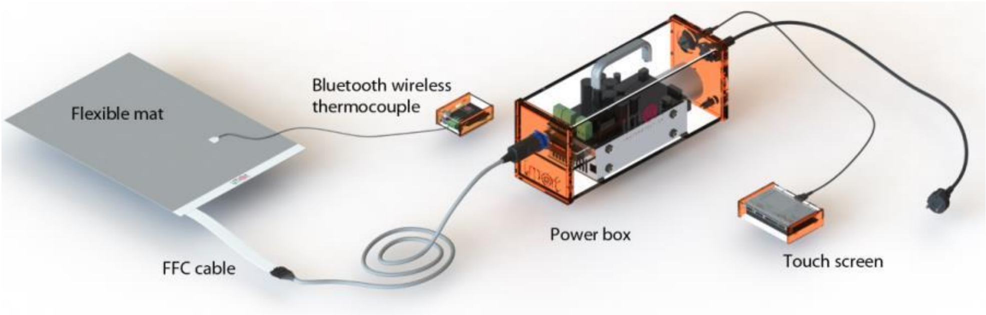

Figure 6 – Conceptual design of overall IMAT architecture

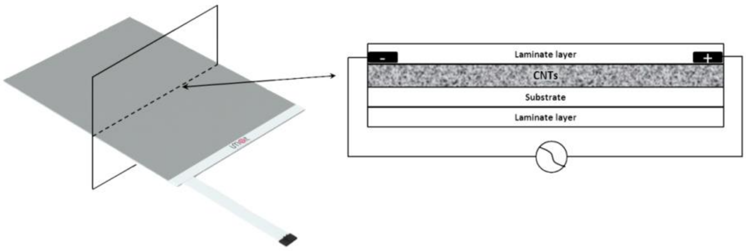

Figure 7 – Basic composition of IMAT

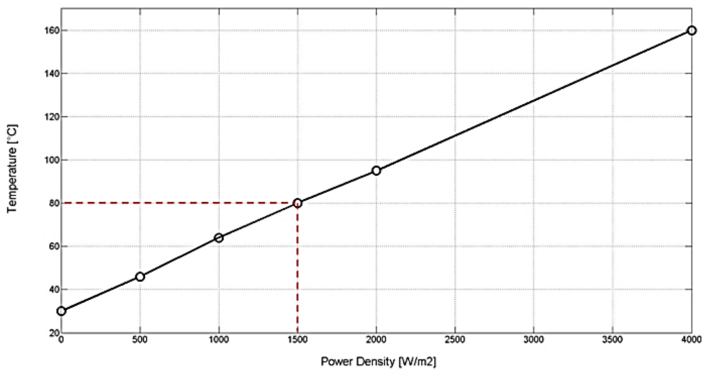

Figure 8 –Power density vs. temperature; the curve, almost linear, is obtained experimentally

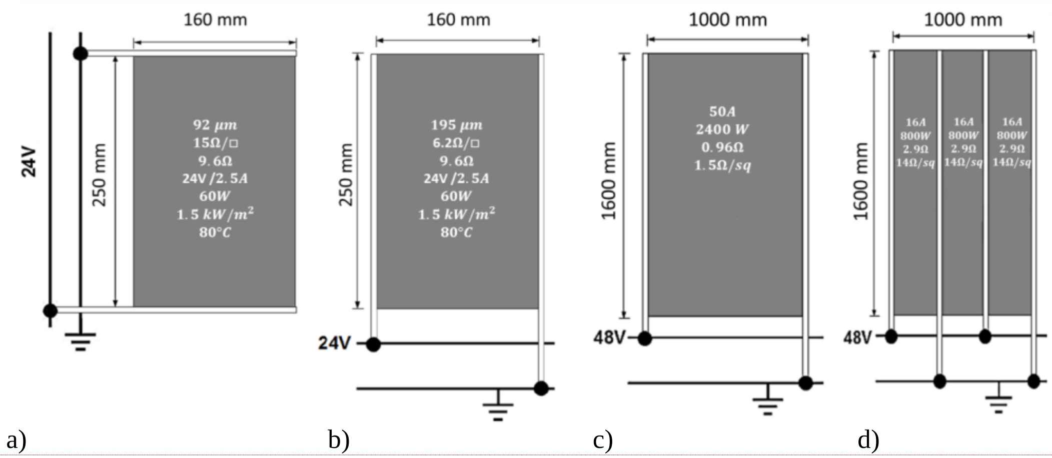

Figure 9 – Carbo e-Therm coating properties for the exemplificative case in which electrodes are placed along the long sides of the coated area; b) Carbo e-Therm coating properties for the exemplificative case in which electrodes are placed along the short sides of the coated area; c) Power needs for larger sizes; d) segmentation, allowing for a reduction in power needs, thereby increasing sheet resistance.

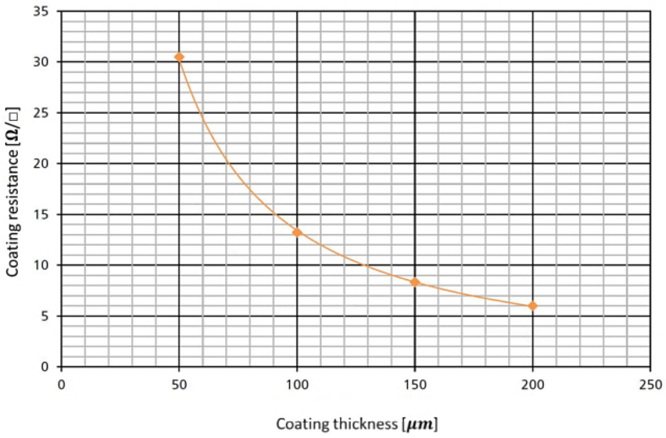

Figure 10 – Coating resistance vs. coating thickness.

	IMAT-S (Standard)	IMAT-T (Transparent)	IMAT-B (Breathable)
Temperature range:	20-85°C max	20-55°C max	20-55°C max
Coating:	Silicon / Teflon / PUR		
Substrate:	Silicone coating laminate, light grey or red in colour.	transparent	perforated
Electrodes:	on side edges	on side edges	on side edges
(Optimum) Size:	A5-A0	A5-A4	A5-A4

Table 1 – IMAT functional requirements

Figure 11 – Transparent polyester film and polyamide textile coated with Carbo e-Therm.

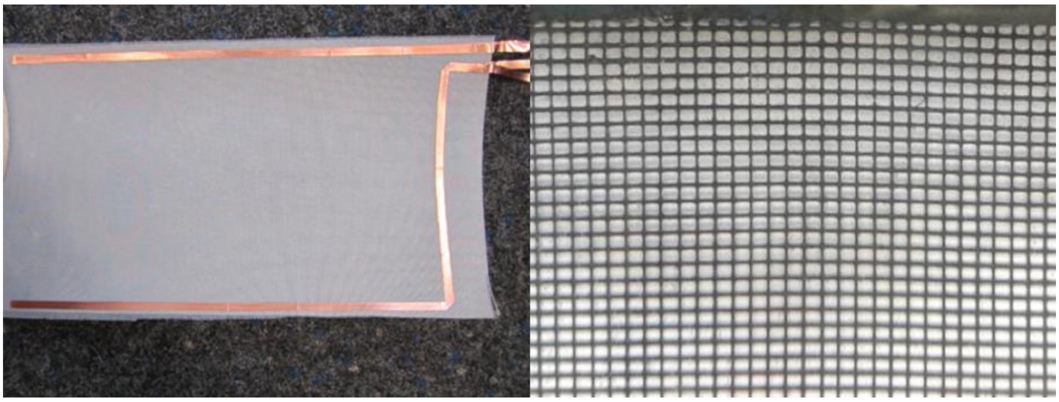

Figure 12 – Fine and coarse textile meshes.

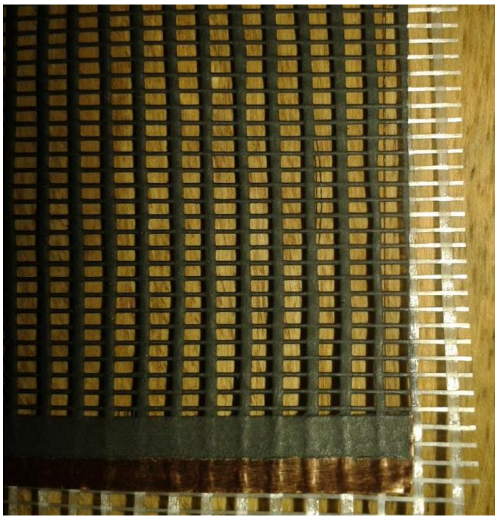

Figure 13 – glass fiber grid.

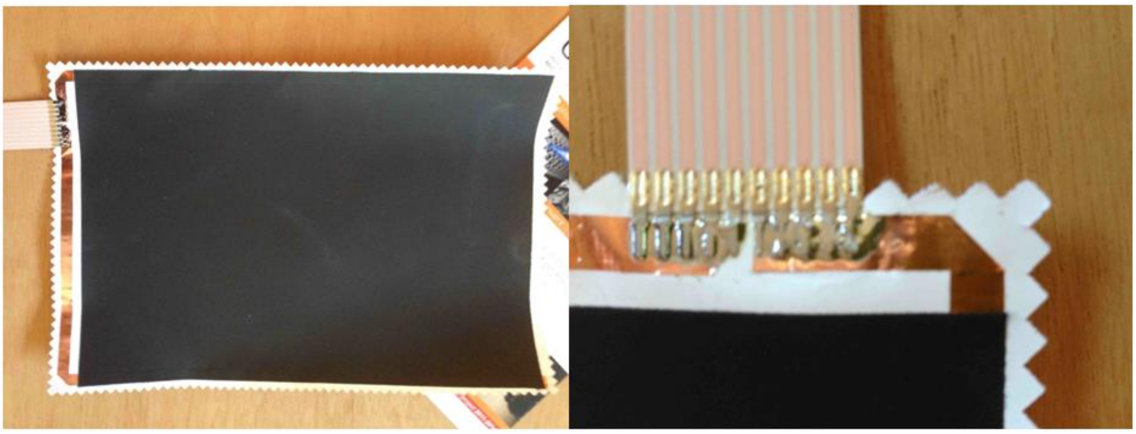

Figure 14 – IMAT-S where the substrate is coated by printing process.

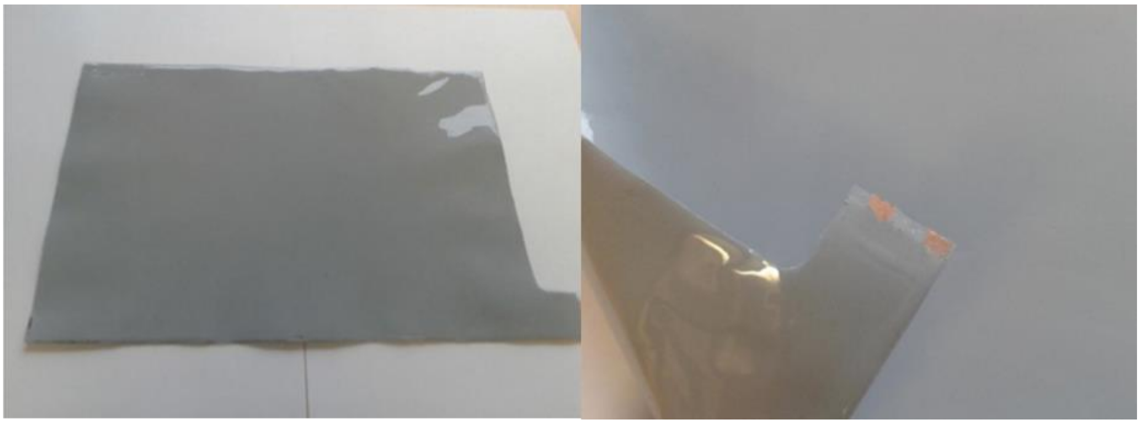

Figure 15 – IMAT heater with protective silicone top coating applied on top of all by doctor blade.

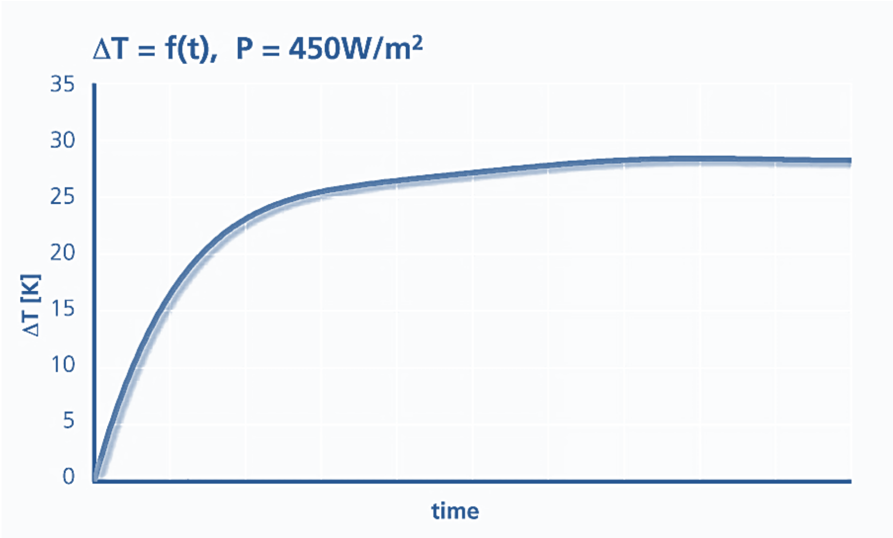

Figure 16 –SEFAR Powerheat 1st generation heating curve

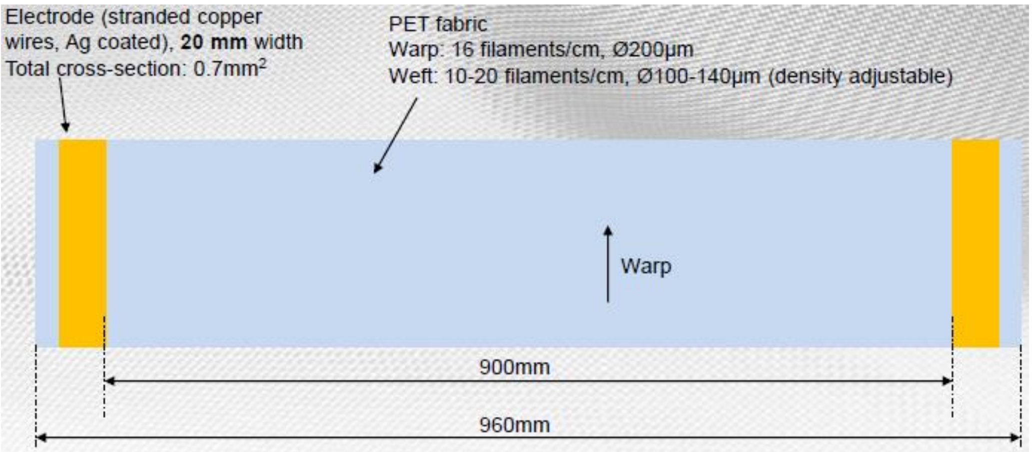

Figure 17 – Fabric V1a structure

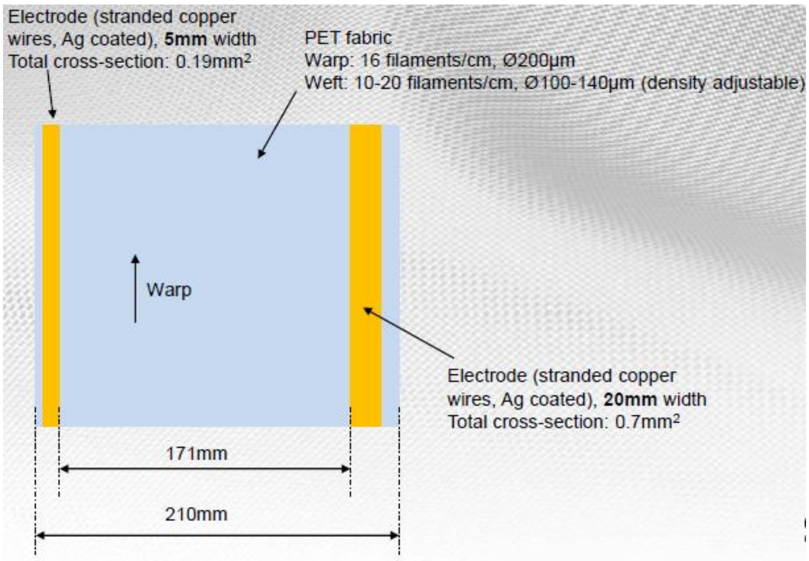

Figure 18 – Fabric V1b structure

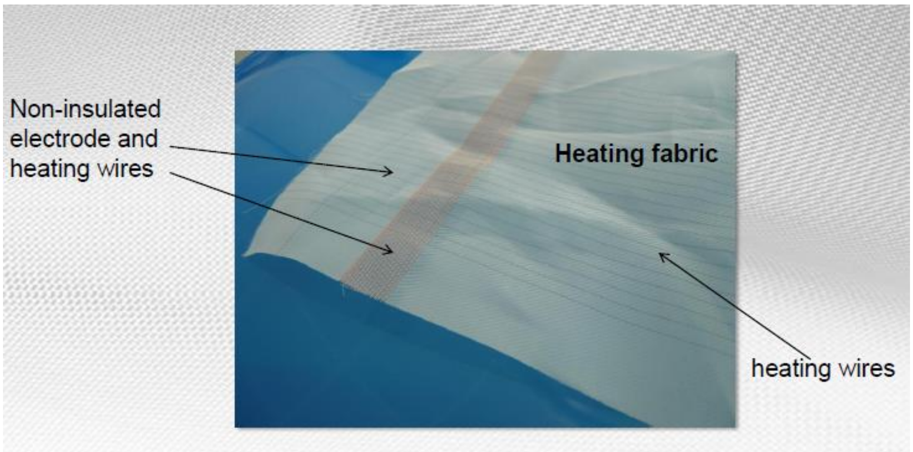

Figure 19 – 2nd generation Power Heat

Figure 20 – an example of early transparent heater

Figure 21 – an example of early transparent heater with fine mesh

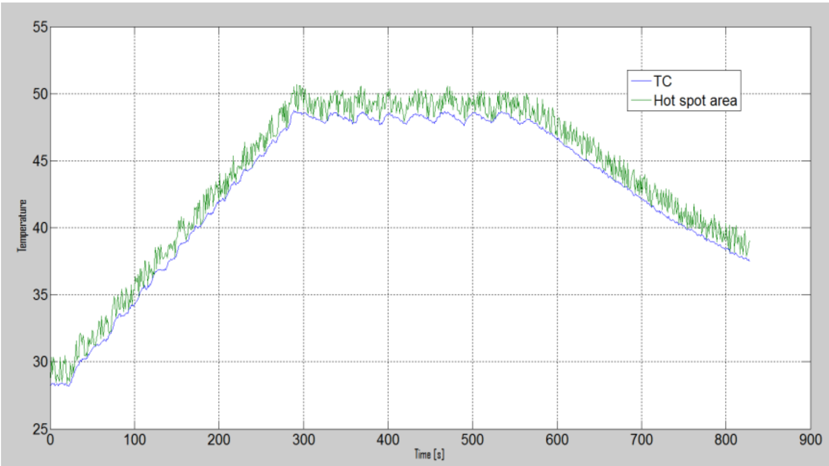

Figure 22 –temperature trends for fine meshes-based transparent heater using a temperature test rising from 30°C to 50°C.

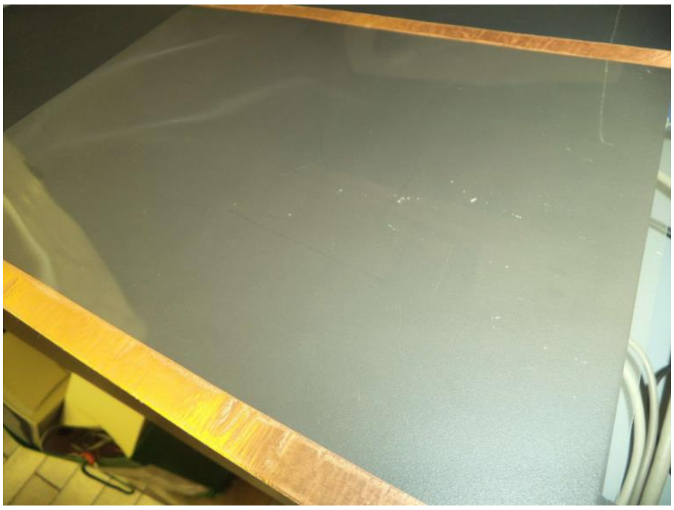

Figure 23 – detected imperfections on the film

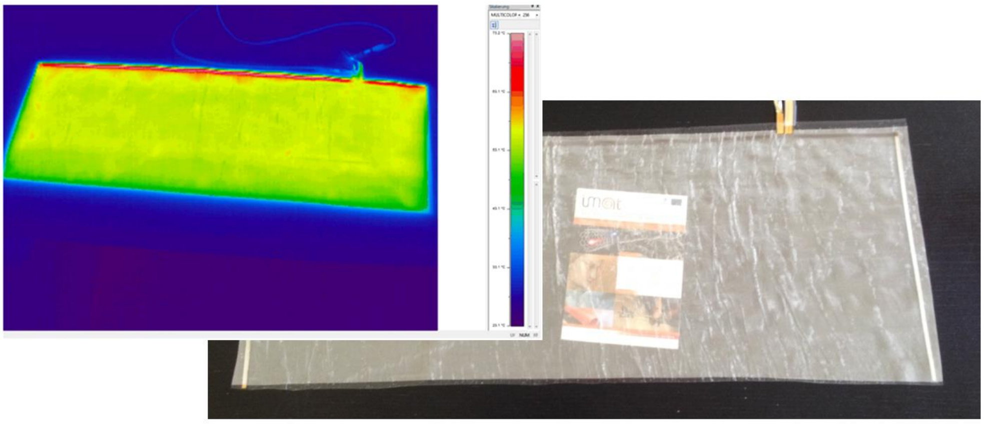

Figure 24 – final heater based on translucent silver coated heating fabric

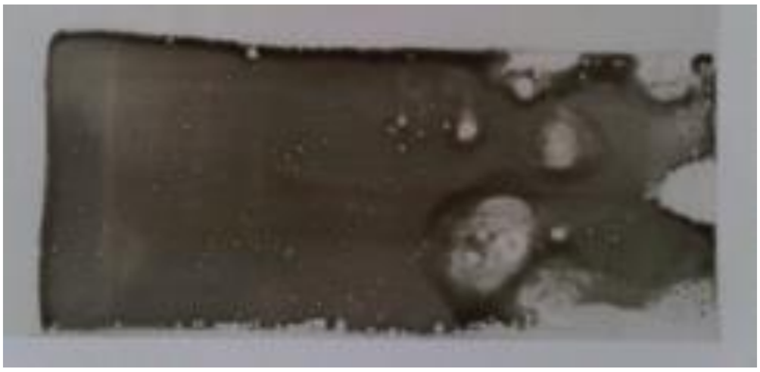

Figure 25 – Preparation of SWCNT dispersion

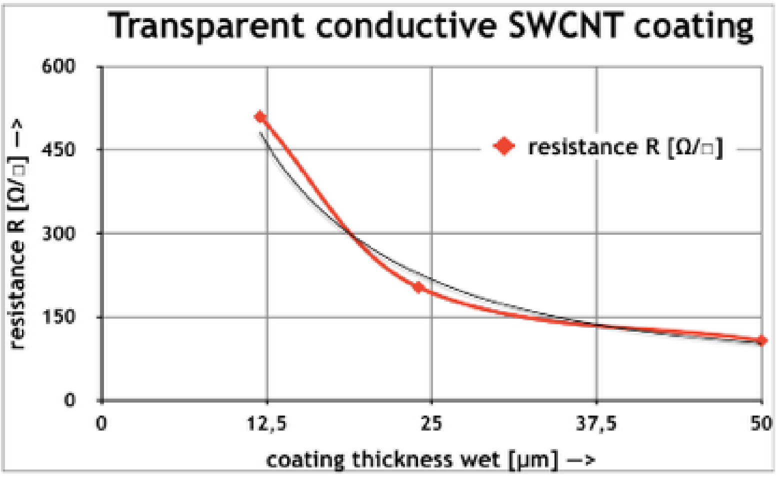

Figure 26 – sheet resistance vs. coating thickness wet

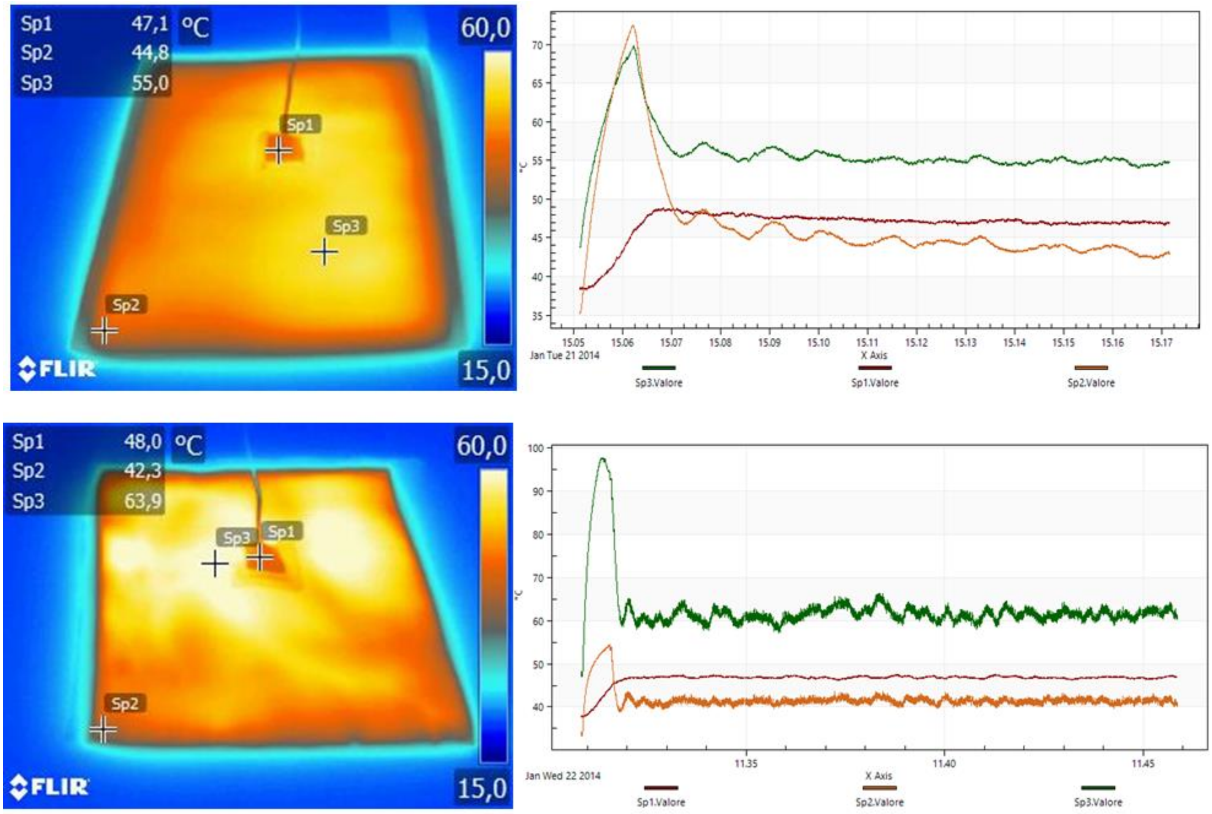

Figure 27 – Thermal image of early prototypes at 50°C and punctual temperatures (upper images IMAT-S, lower images IMAT-B).

Figure 28 – IMAT-S: fiberglass substrate with PUR 200 MWCNTs.

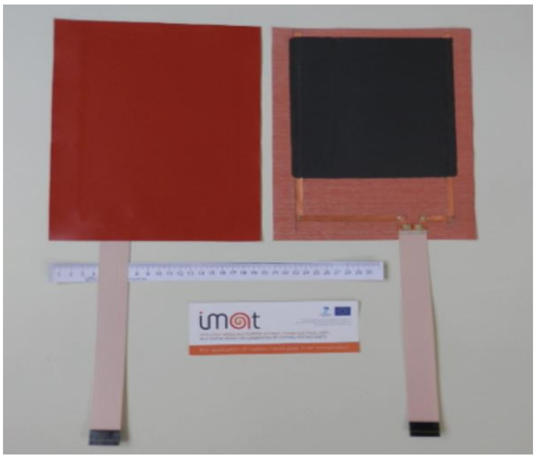

Figure 29 – IMAT-S final prototype

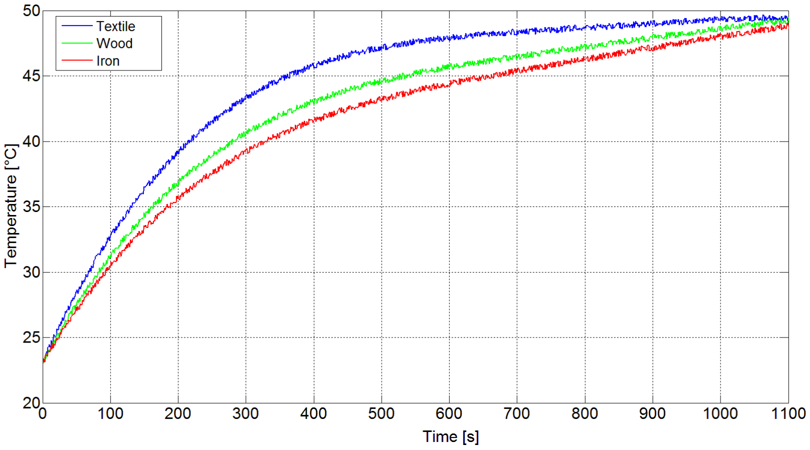

Figure 30 – Temperature trends in a selected point of the IMAT-S coupled with respectively, a wooden desk, a metal table and a textile substrate.

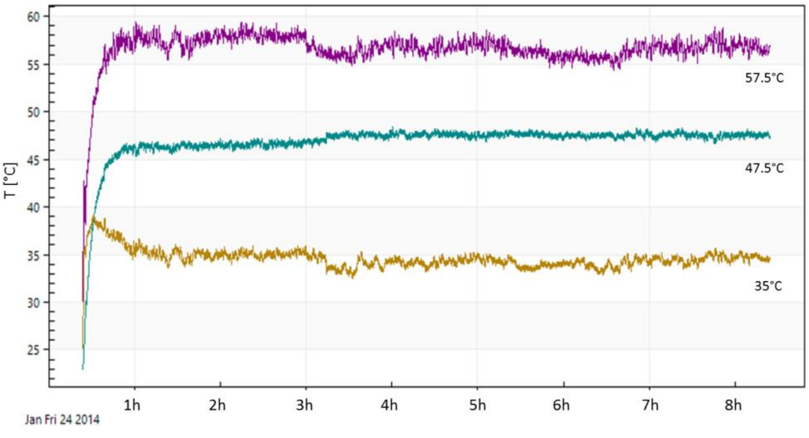

Figure 31 – Temperature trends in a selected point of the IMAT-S tested for eight consecutive hours using three reference temperatures.

Figure 32 – IMAT-B-1 prototypes (fine meshes and multifilament meshes)

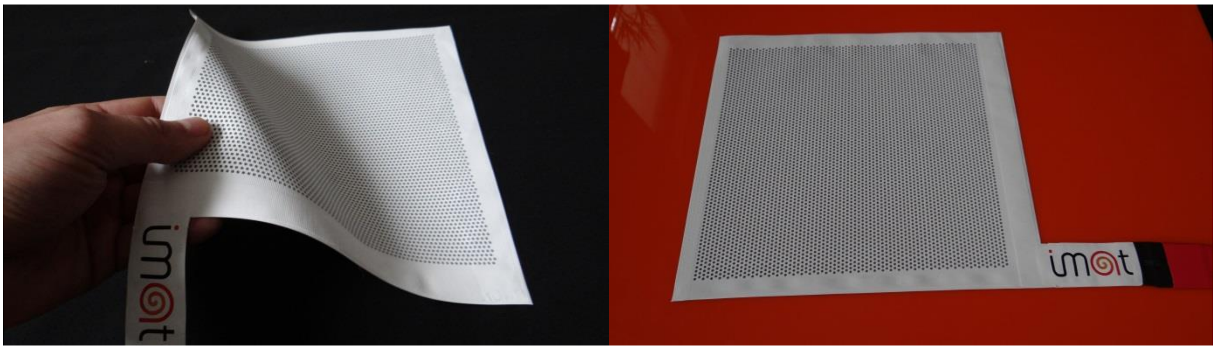

Figure 33 – example of IMAT-B-2 prototypes

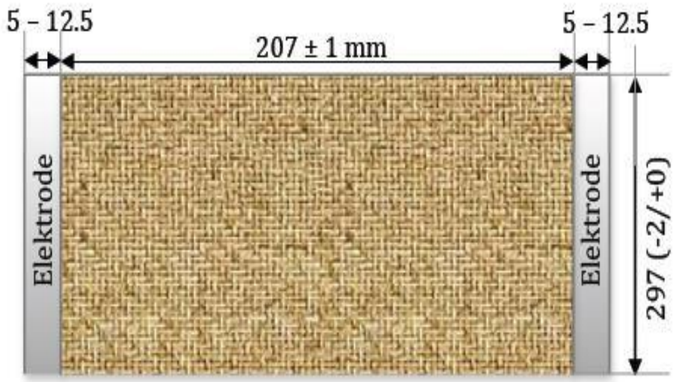

Figure 34 –Design of new generation of SEFAR Tetex to be used as substrate for the breathable heater: design for 36V.

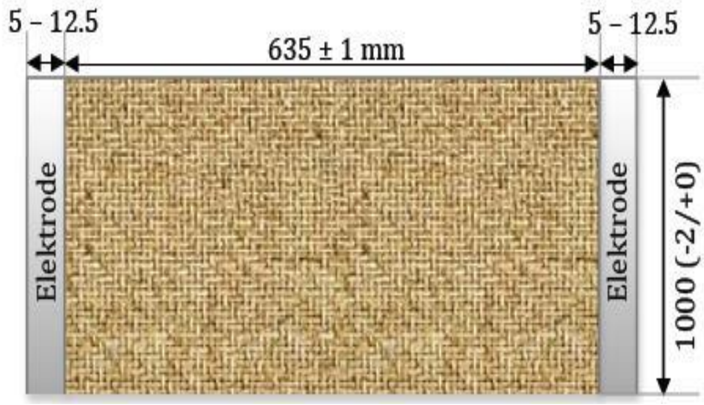

Figure 35 –Design of new generation of SEFAR Tetex to be used as substrate for the breathable heater: design for 96V.

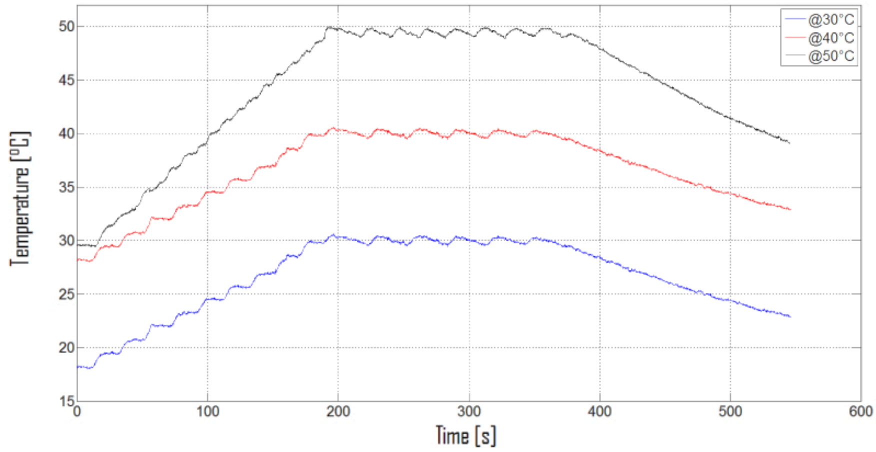

Figure 36 – thermal response in correspondence of the TC for IMAT-S working at different temperatures

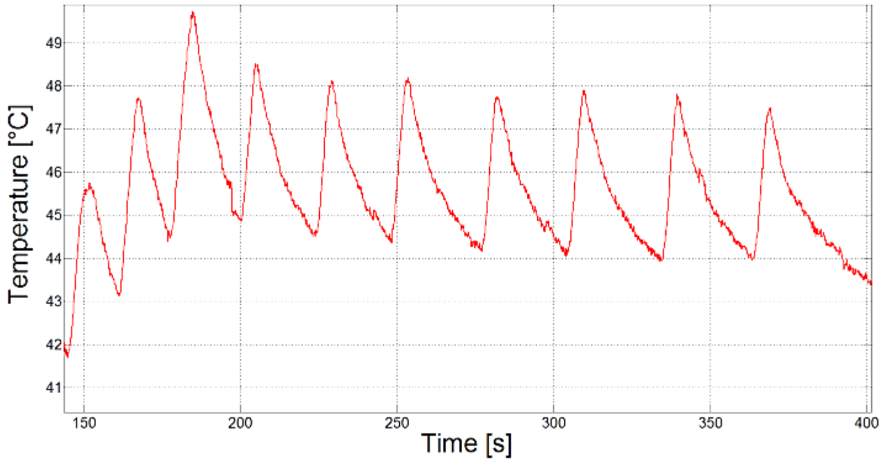

Figure 37 – temperature trends under convective heat transfer conditions obtained using a 2m/s air flow.

Figure 38 – a detail of an IMAT-T-1 sample and a mini-sized IMAT-T-1 sample.

Mesh opening	Open area	Mesh count warp	Mesh count weft	Wire diameter warp	Wire diameter weft	weight	thickness
µm	%	n/cm	n/cm	µm	µm	g/m^2	µm
465	49	15	15	200	200	150	365

Table 2 - SEFAR PEN 30-60 properties

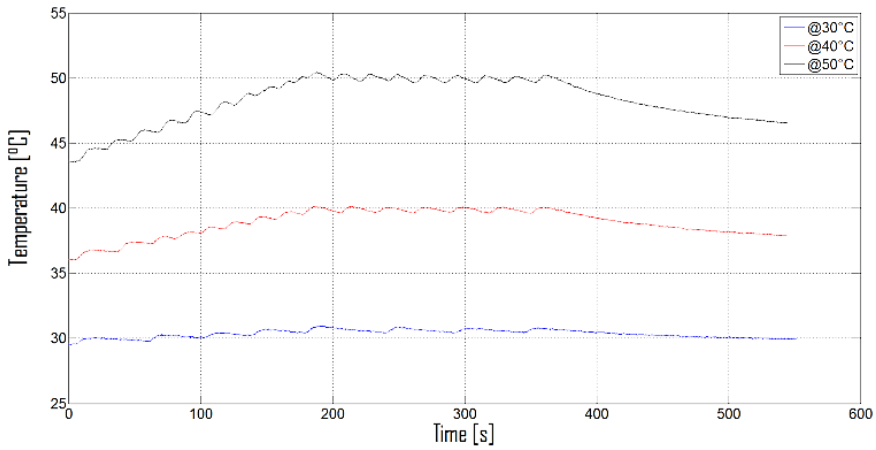

Figure 39 – thermal response in correspondence of the TC for IMAT-T-1 working at different temperatures with new PID values and with higher starting temperature.

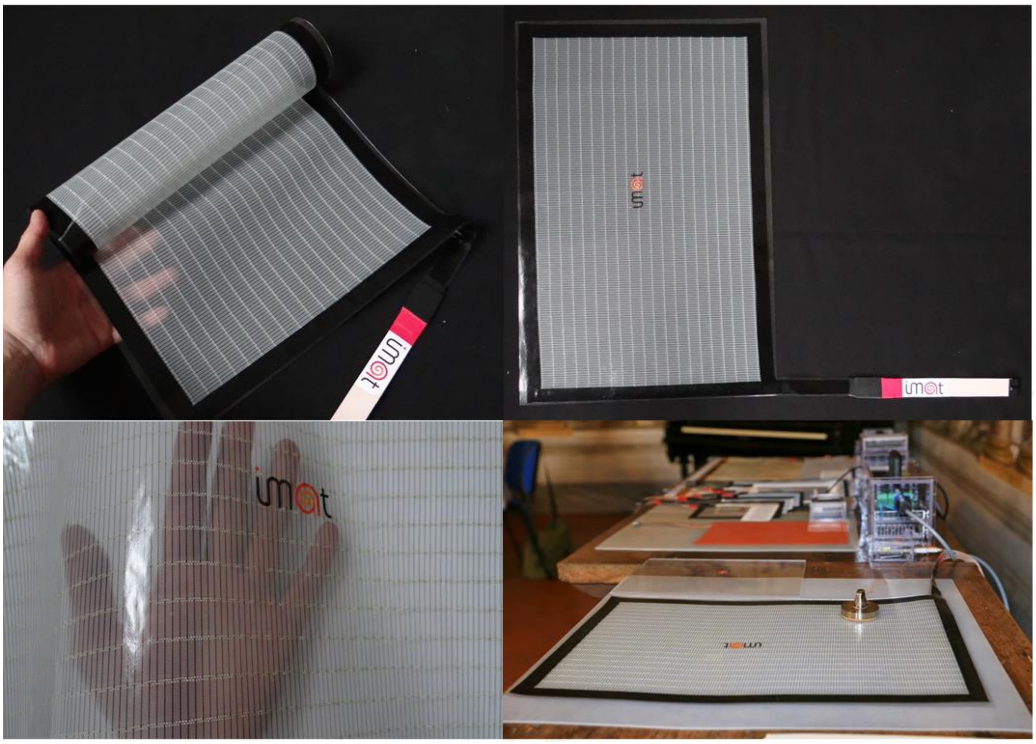

Figure 40 – Examples of IMAT-T-2 prototypes

IMAT prototype	D_{RGB}	Transmittance (IP-T)	Transmittance (spectrophotometer)
IMAT-T-1	87.88	71.03%	72.83%
IMAT-T-2	128.32	80.19%	82.21%

Table 3 – Transparency results obtained by using IP-T and spectrophotometer methods respectively.

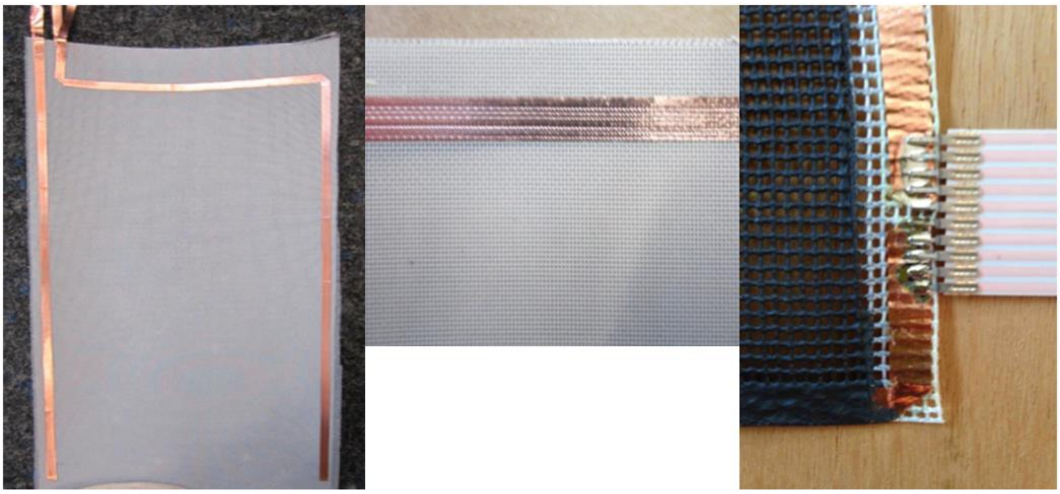

Figure 41 – Extremely thin copper electrodes for IMAT heaters

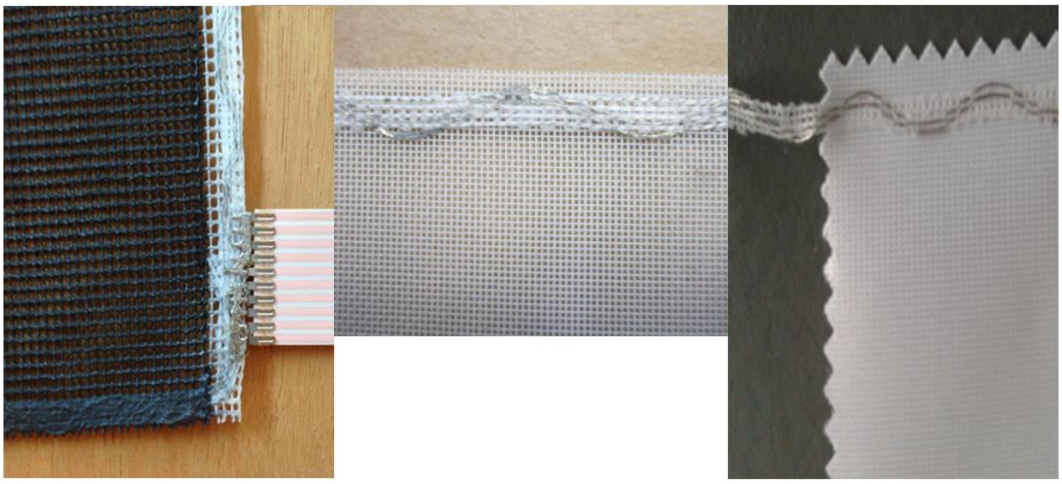

Figure 42 – sewed on wires for IMAT heaters

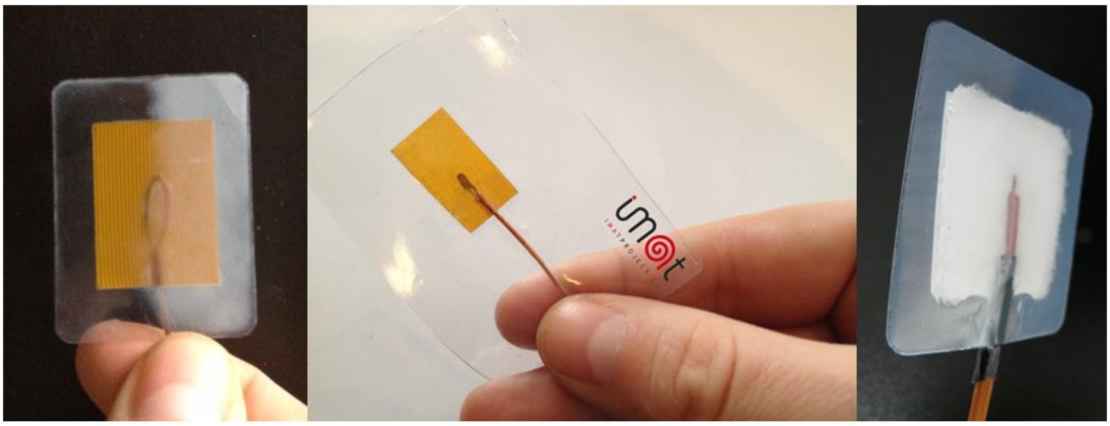

Figure 43 – external thermocouples integrated in flat films for use with the IMAT thermal controls

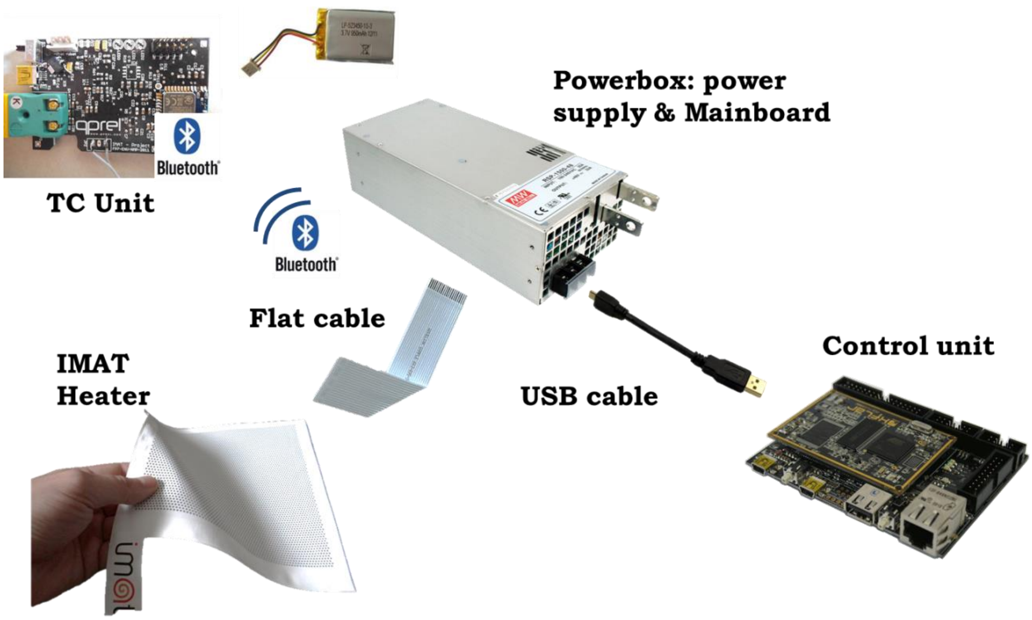

Figure 44 – electronic Concept of IMAT Console

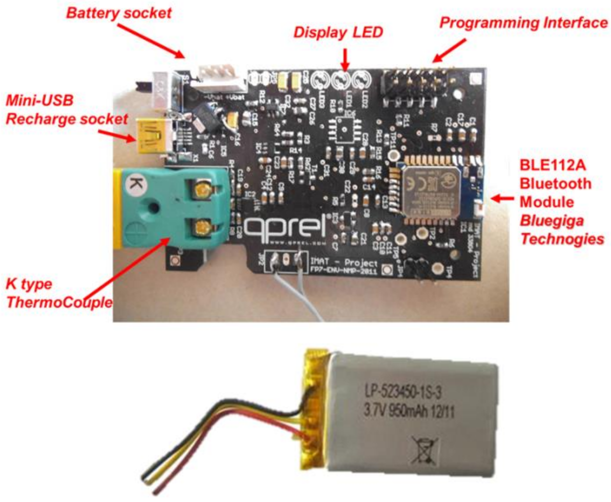

Figure 45 – TC unit components

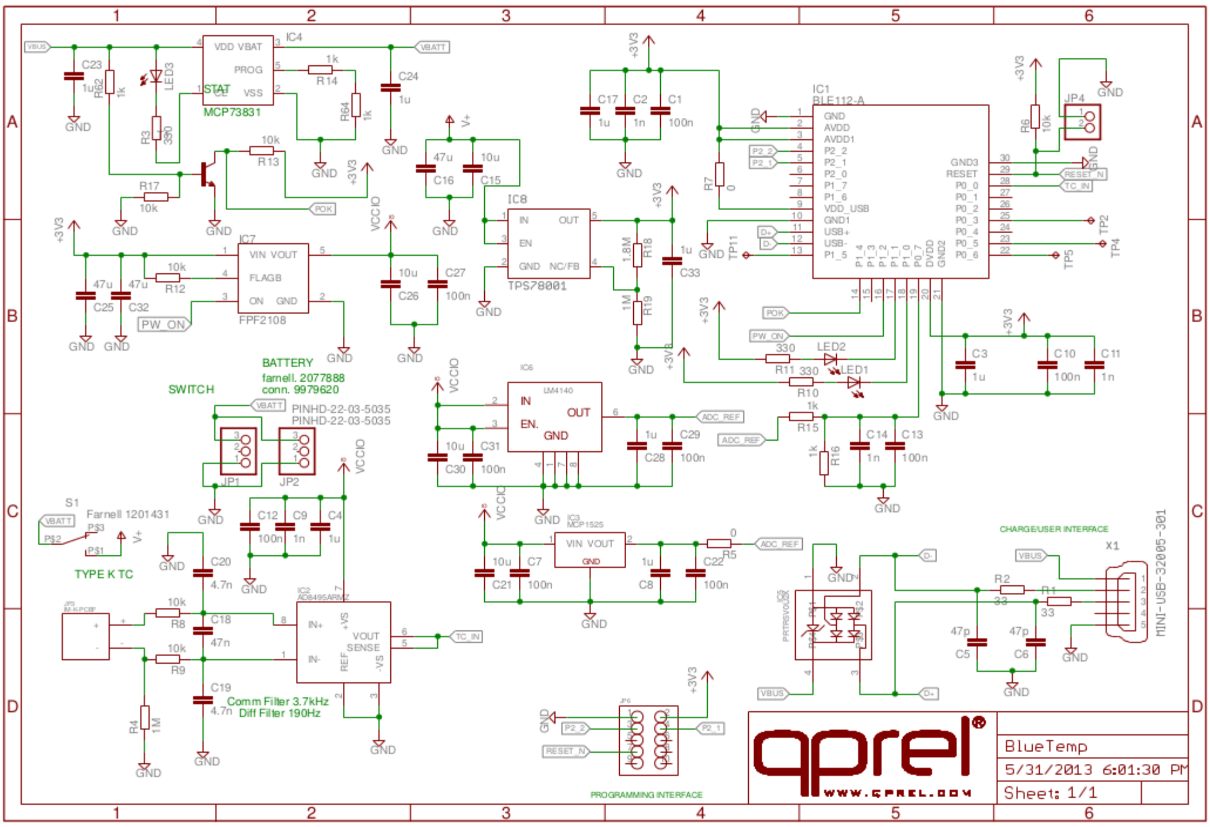

Figure 46 –IMAT TC Board electric schematic. Bluegiga BLE112A module has been shown (IC1) as the TC signal conditioning chip (IC2) and the recharging circuit (IC4)

	Parameter	Value
Output	DC Voltage	36V
	Rated Current	17.5A
	Current range	0-17.5A
	Rated Power	630W
	Ripple & Noise	200mVp - p
	Voltage Adjustable range	28.8V – 39.6V
	Voltage Tolerance	±1%
Input	Voltage Range	85 ~ 264VAC 120 ~ 370VDC
	Frequency Range	47 ~ 63Hz
	Power Factor	PF>0.94/230VAC PF>0.99/115VAC at full load
	Efficiency	89%
	AC Current	7.6A/115VAC 3.6A/230VAC
	Inrush Current	35A/115VAC 70A/230VAC
	Leakage Current	<1.2mA / 240VAC
Protection	Overload	105 ~ 135% rated output power
	Over Voltage	41.4 ~ 48.6V
	Over Temperature	Shut down o/p voltage, recovers automatically after temperature goes down
Function	Fan Control	Load 35±15% or RTH2≧50℃ Fan on
	DC OK Signal	PSU turn on : 3.3~5.6V ; PSU turn off : 0~1V
Environment	Working Temperature	-40 ~ +70℃
	Working humidity	20 ~ 90% RH non-condensing
	Weight	1.5 Kg

Table 4 - Specs for HRP-600-36 series

MODEL		RSP-1500-5	RSP-1500-12	RSP-1500-15	RSP-1500-24	RSP-1500-27	RSP-1500-48
OUTPUT	DC VOLTAGE	5V	12V	15V	24V	27V	48V
	RATED CURRENT	240A	125A	100A	63A	56A	32A
	CURRENT RANGE	0 ~ 240A	0 ~ 125A	0 ~ 100A	0 ~ 63A	0 ~ 56A	0 ~ 32A
	RATED POWER	1200W	1500W	1500W	1512W	1512W	1536W
	RIPPLE & NOISE (max.) Note.2	150mVp-p	150mVp-p	150mVp-p	150mVp-p	150mVp-p	200mVp-p
	VOLTAGE ADJ. RANGE	4.5 ~ 5.5V	10 ~ 13.5V	13.5 ~ 16.5V	20 ~ 26.4V	24 ~ 30V	43 ~ 56V
	VOLTAGE TOLERANCE Note.3	±2.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%
	LINE REGULATION	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
	LOAD REGULATION	±2.0%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
	SETUP, RISE TIME	1500ms, 100ms at full load					
	HOLD UP TIME (Typ.)	10ms at full load		14ms at full load		16ms at full load	
INPUT	VOLTAGE RANGE	90 ~ 264VAC 127 ~ 370VDC					
	FREQUENCY RANGE	47 ~ 63Hz					
	POWER FACTOR (Typ.)	0.95/230VAC 0.98/115VAC at full load					
	EFFICIENCY (Typ.)	80%	87%	87%	90%	90%	91%
	AC CURRENT (Typ.)	17A/115VAC 8A/230VAC					
	INRUSH CURRENT (Typ.)	30A/115VAC 60A/230VAC					
	LEAKAGE CURRENT	<2.0mA / 240VAC					
PROTECTION	OVERLOAD Note.5	105 ~135% rated output power					
		Protection type : Constant current limiting unit will shut down o/p voltage after 5sec. Re-power on to recover					
	OVER VOLTAGE	5.75 ~ 6.75V	13.8 ~ 16.8V	17 ~ 20.5V	27.6 ~ 32.4V	31 ~ 36.5V	57.6 ~ 67.2V
		Protection type : Shut down o/p voltage, re-power on to recover					
	OVER TEMPERATURE	Shut down o/p voltage, recovers automatically after temperature goes down					
FUNCTION	AUXILIARY POWER(AUX)	12V@0.1A(Only for Remote ON/OFF control)					
	REMOTE ON/OFF CONTROL	Please see the Function Manual					
	ALARM SIGNAL OUTPUT	Please see the Function Manual					
	OUTPUT VOLTAGE TRIM	Please see the Function Manual					
	CURRENT SHARING	Please see the Function Manual					
ENVIRONMENT	WORKING TEMP.	-20 ~ +70℃ (Refer to "Derating Curve")					
	WORKING HUMIDITY	20 ~ 90% RH non-condensing					
	STORAGE TEMP., HUMIDITY	-40 ~ +85℃, 10 ~ 95% RH					
	TEMP. COEFFICIENT	±0.05%/℃ (0 ~ 50℃)					

Table 5 - Specs for RSP-1500 series

Figure 47 –power supplies for LV and HV consoles

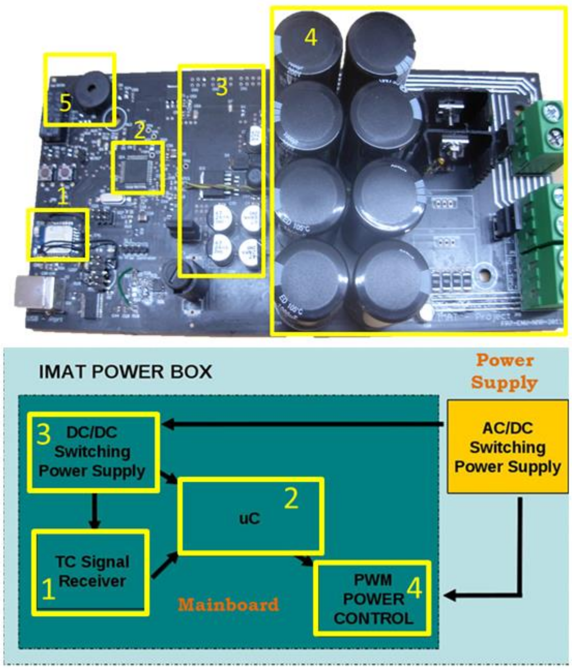

Figure 48 –power unit mainboard

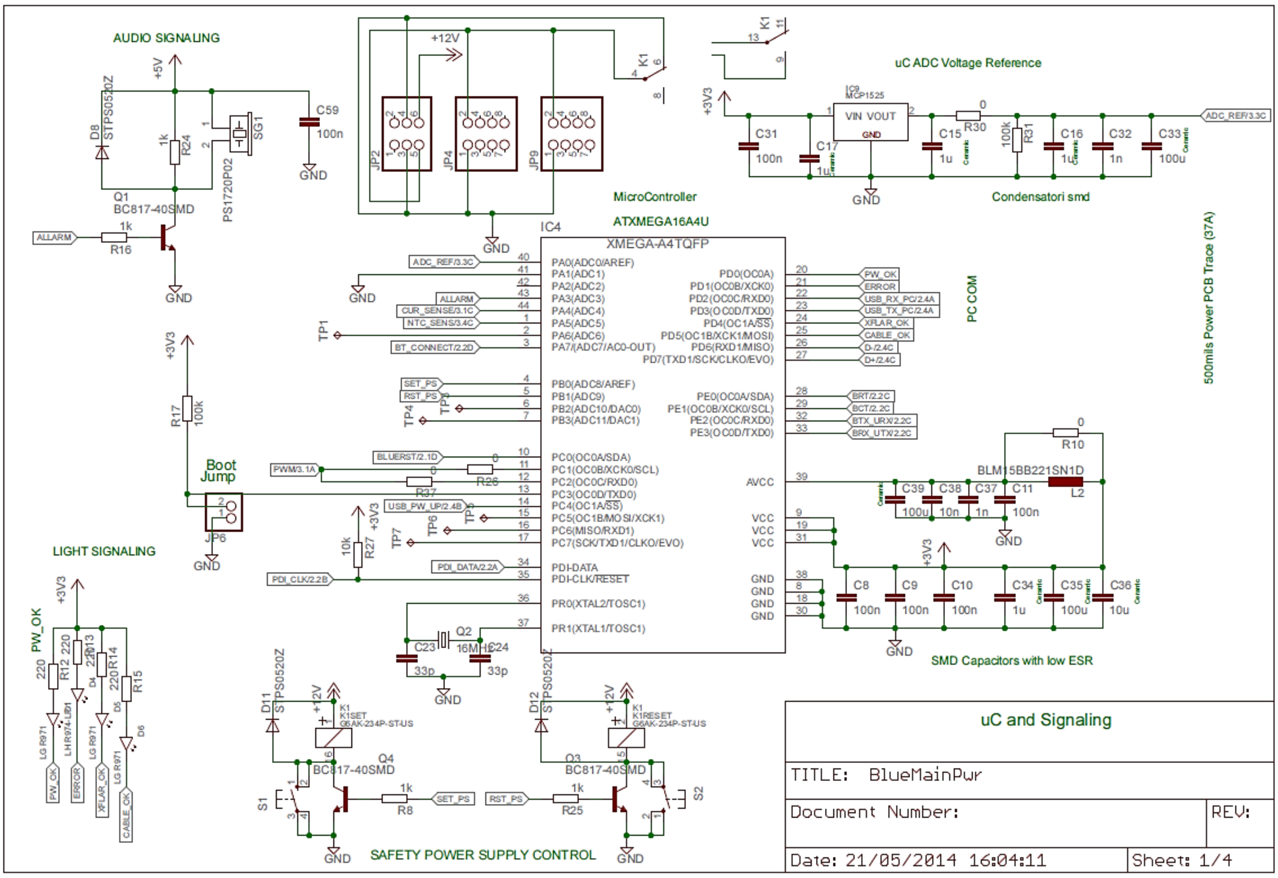

Figure 49 – Main board electric schematics, sheet a: Microcontroller circuit, LEDs for internal debug and buzzer allowing to rise acoustic alarms.

Figure 50 – components of the Control Unit

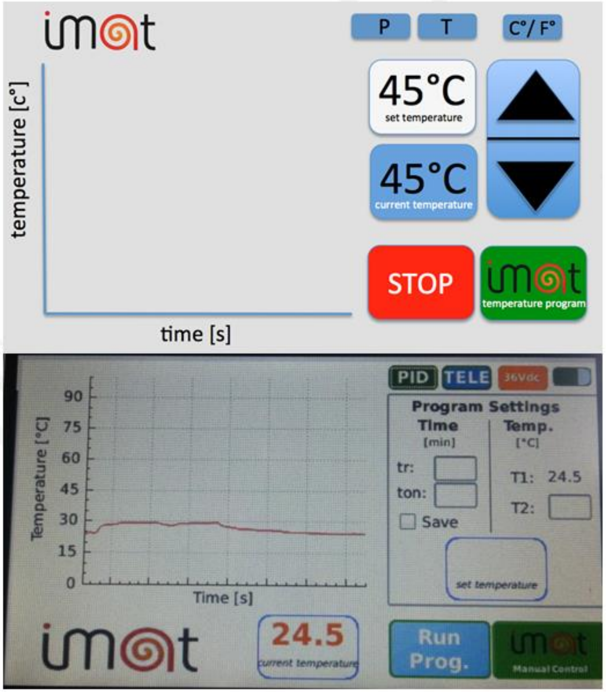

Figure 51 – GUI

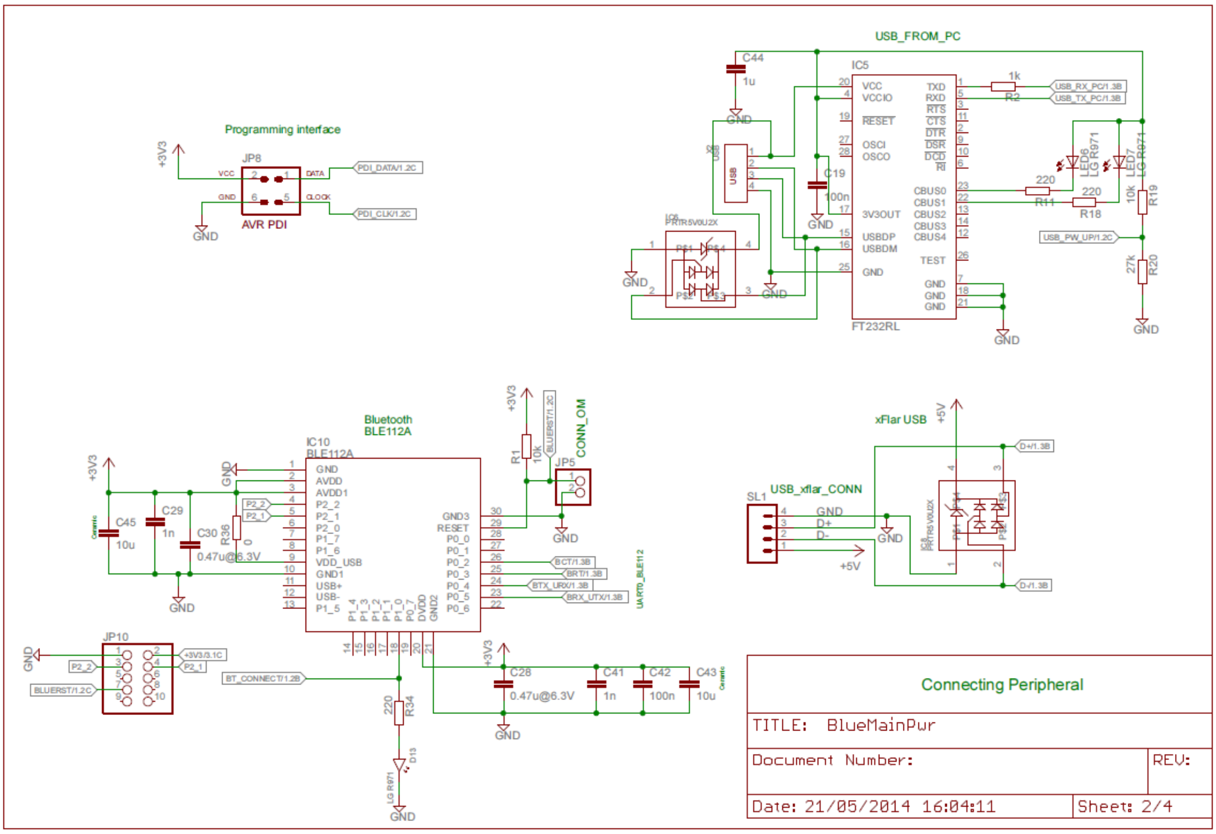

Figure 52 – connecting peripheral

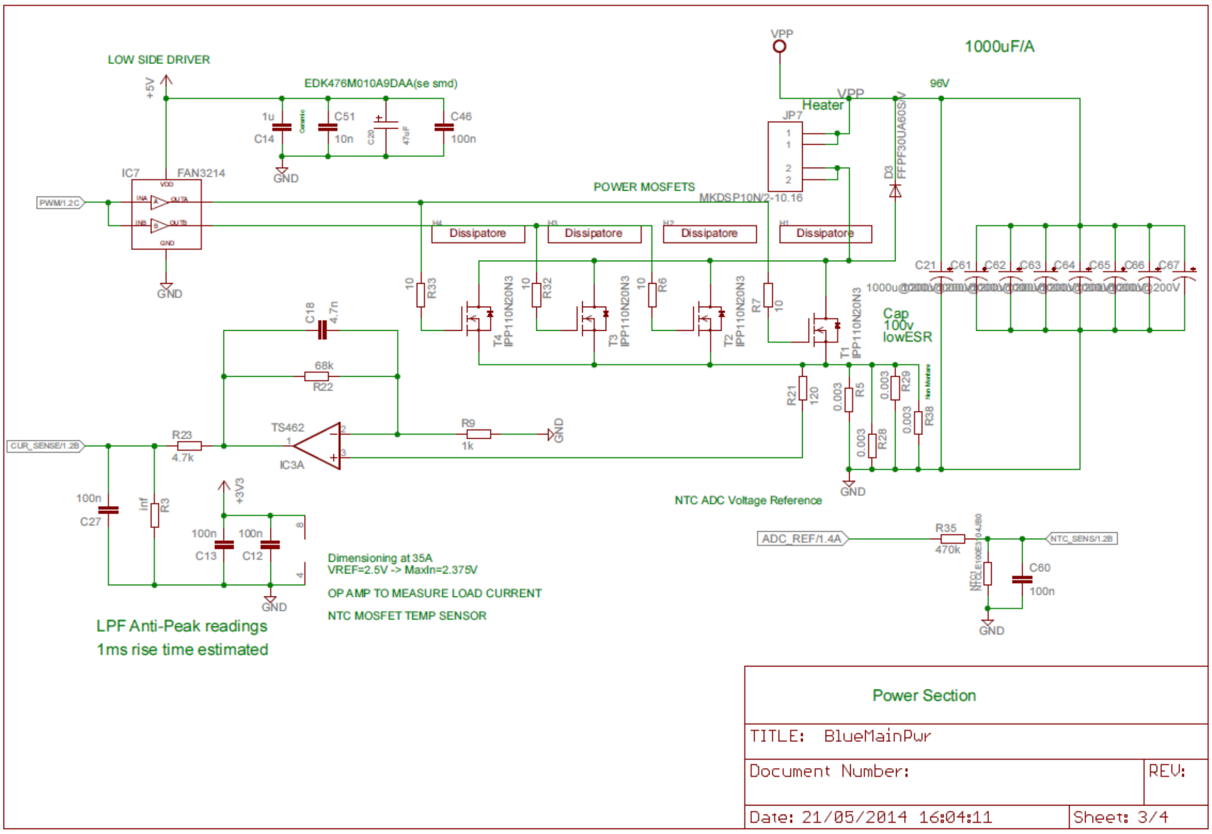

Figure 53 – power section

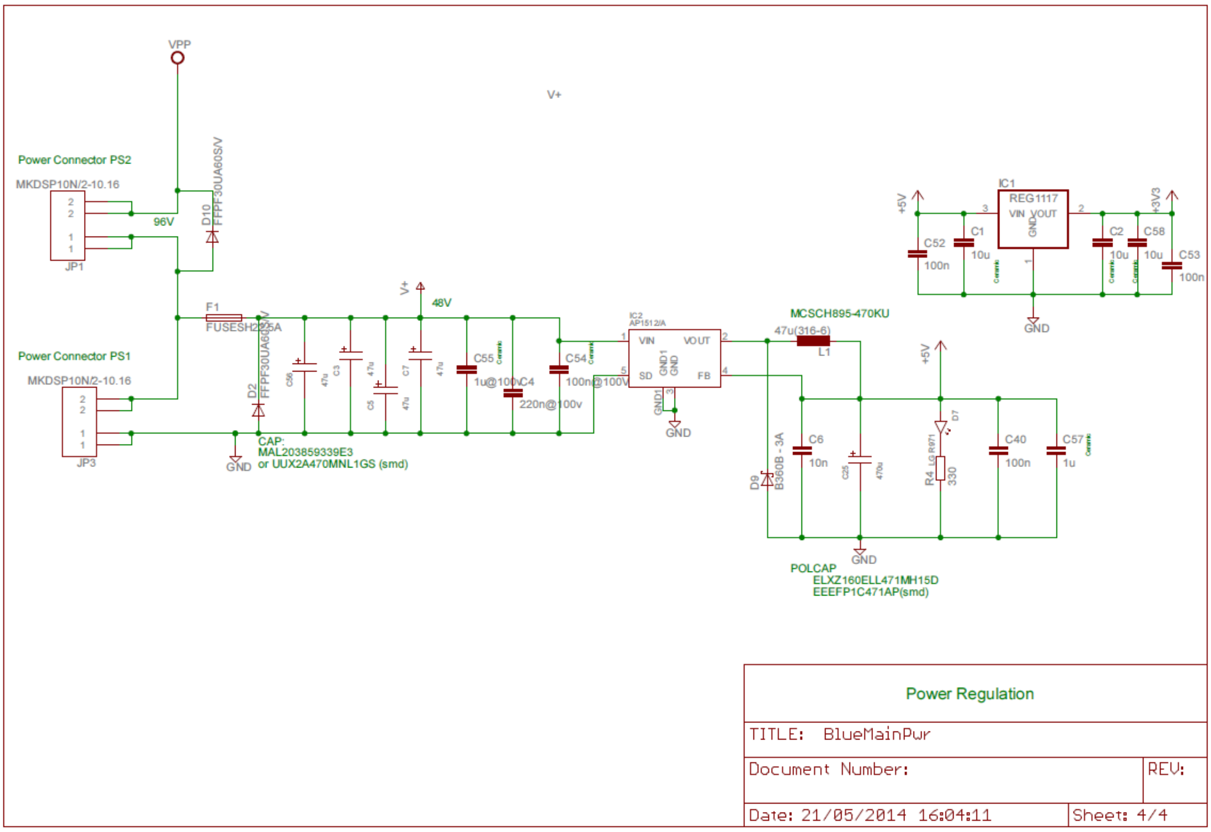

Figure 54 – power regulation

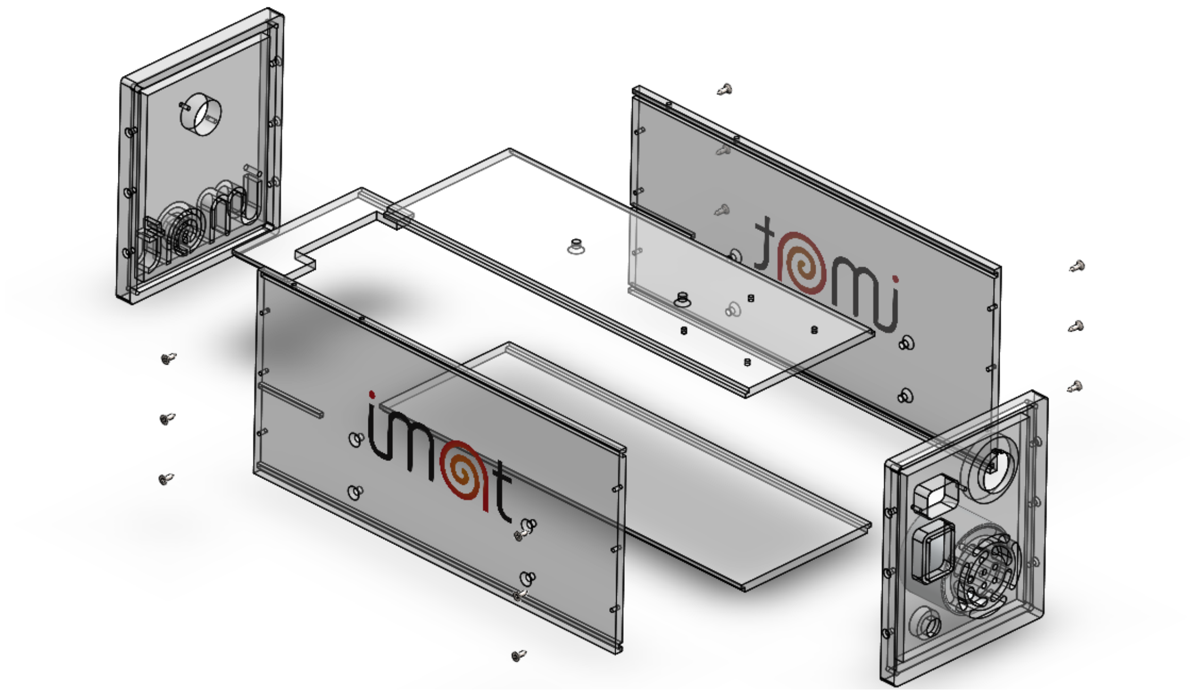

Figure 55 – power regulation

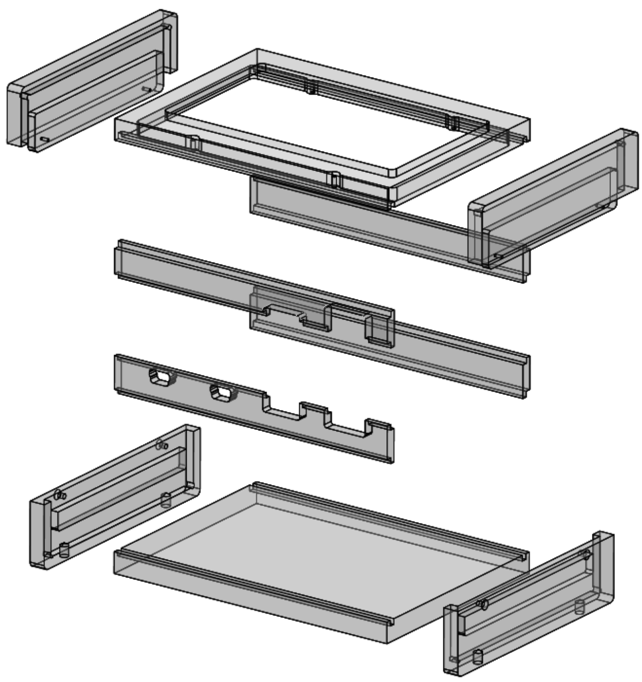

Figure 56 – power regulation

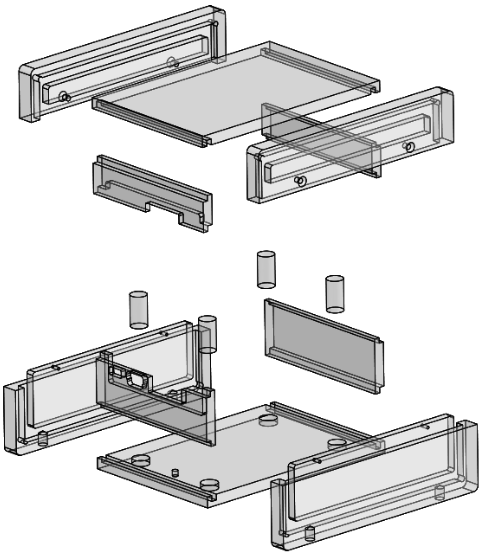

Figure 57 – power regulation

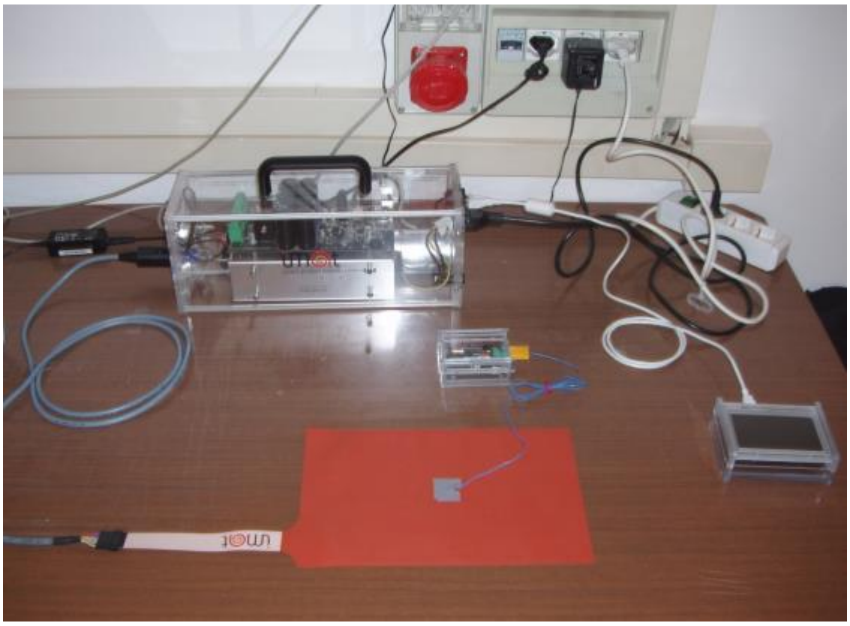

Figure 58 – final console: experimental layout

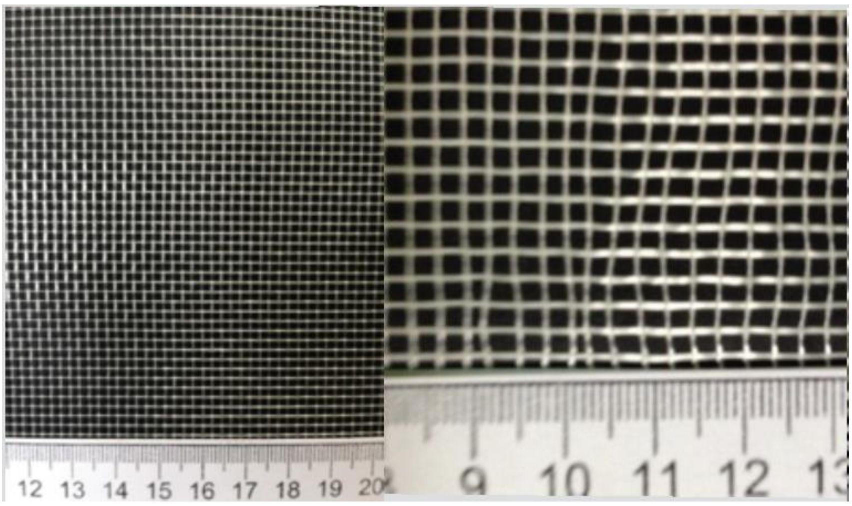

Figure 59 – Fine glass fiber meshes

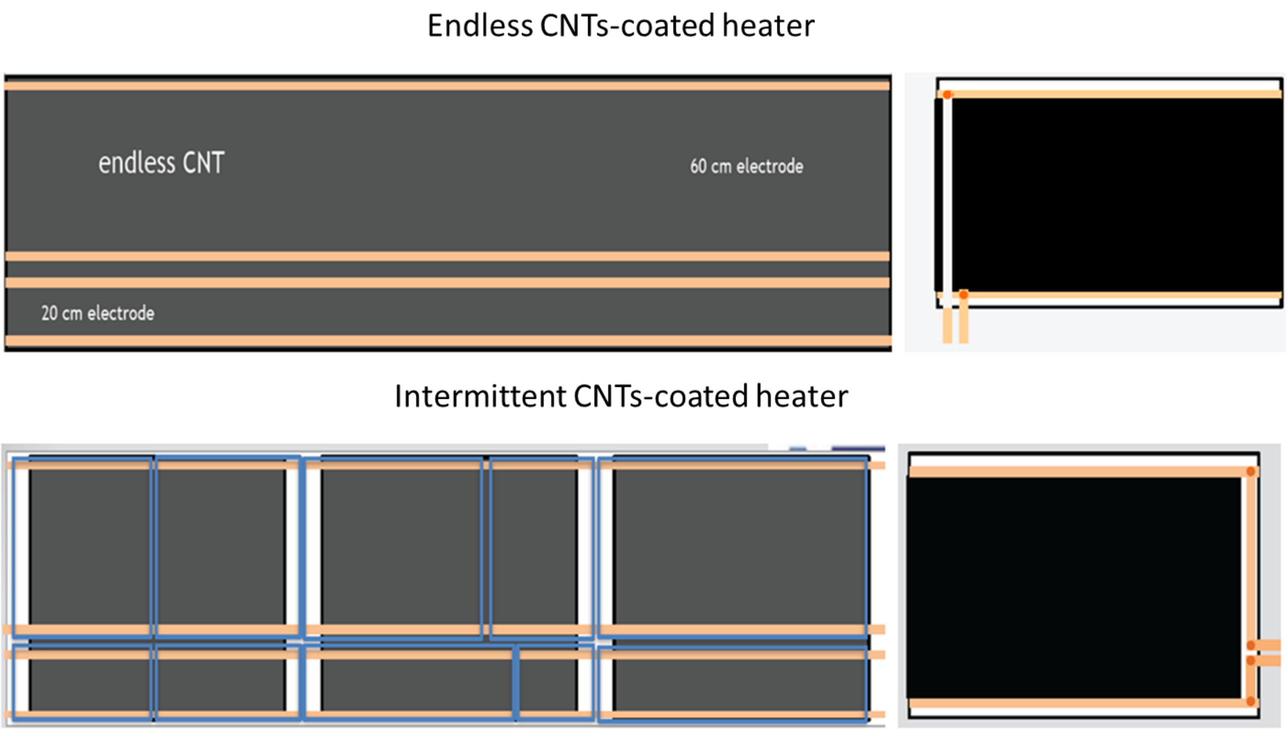

Figure 60 – Electrodes inclusion

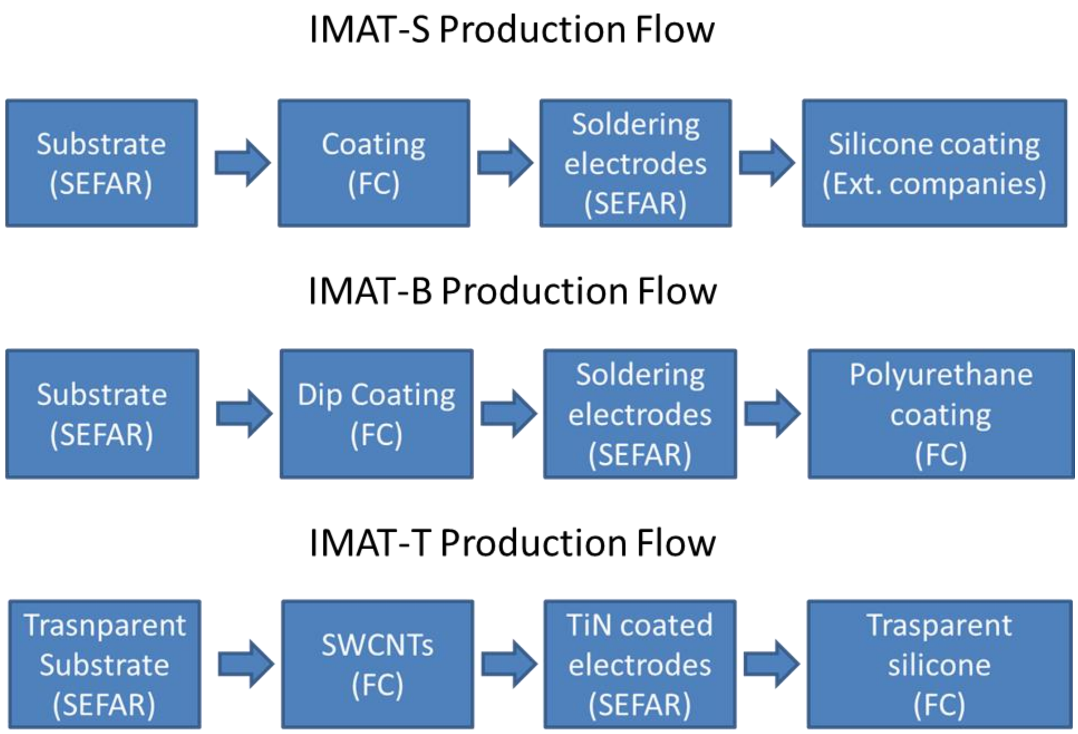

Figure 61 – IMAT heaters production cycle

Figure 62 – IMAT Final results to be obtained for standard IMAT (before adding the protective silicone)

Figure 63 - variety of problems that can be encountered during the restoration of paintings

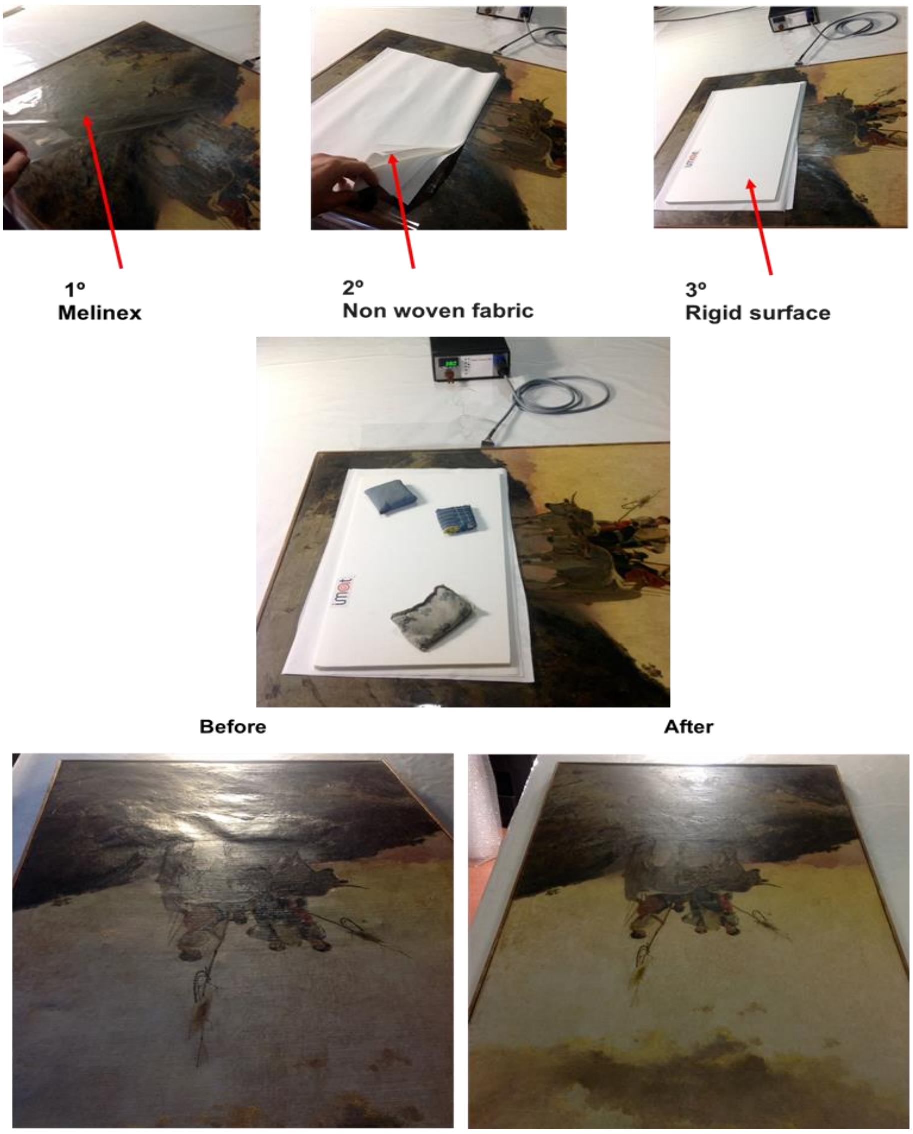

Figure 64 – Application of IMAT on a 19th century painting, oil on canvas.

Figure 65 - Copy of Maria Luisa Infante di Spagna portrait by Lorenzo Tiepolo (XVIII Century, oil on canvas, 70x60 cm, Galleria Palatina di Palazzo Pitti, Florence, Italy

Figure 66 - Spanish panels conserved using also the IMAT device; Left: St. John the Evangelist drinking from the Poisoned Chalice; Right: The Beheading of St. John the Baptist and the Feast of Herod (Suermondt-Ludwig-Museum, Aachen)

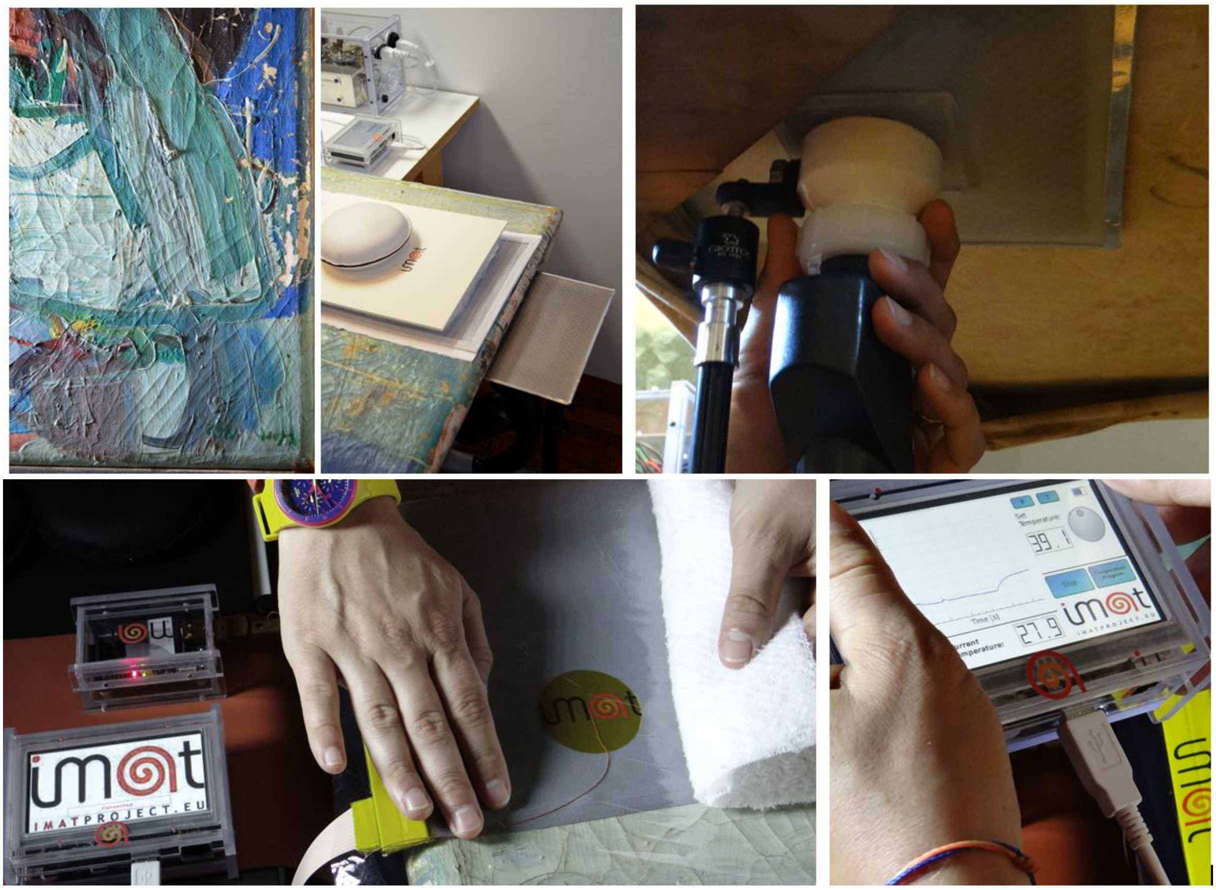

Figure 67 – Photo detail of the surface in oblique light; demonstrative photo of the suction platen, IMAT-B, thermal isolation layer, foamcore; photo of the suction scupper positioned under the canvas; IMAT positioning on the painting and IMAT touchscreen with temperature settings.

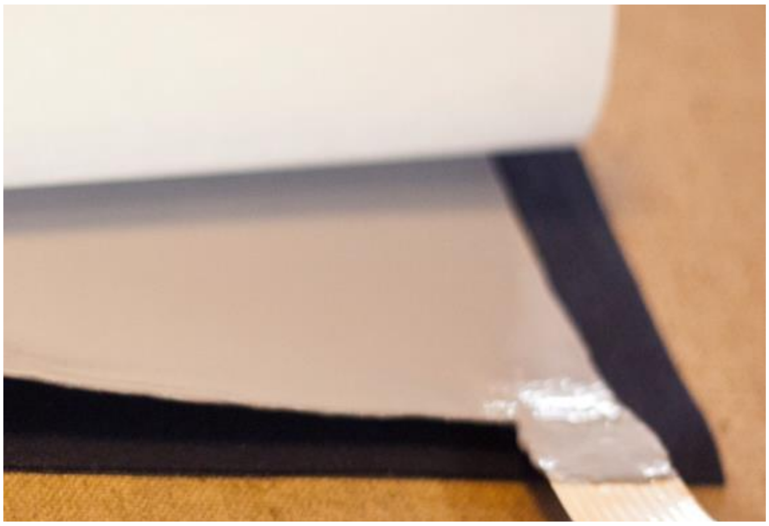

Figure 68 - Use of a Goretex® membrane in combination with IMAT-B.

Figure 69 - Sculpture by an unknown Lithuanian master from 18th century treated using IMAT.

Figure 70 – Conservation of the portrait of Cornelius Janssenius.

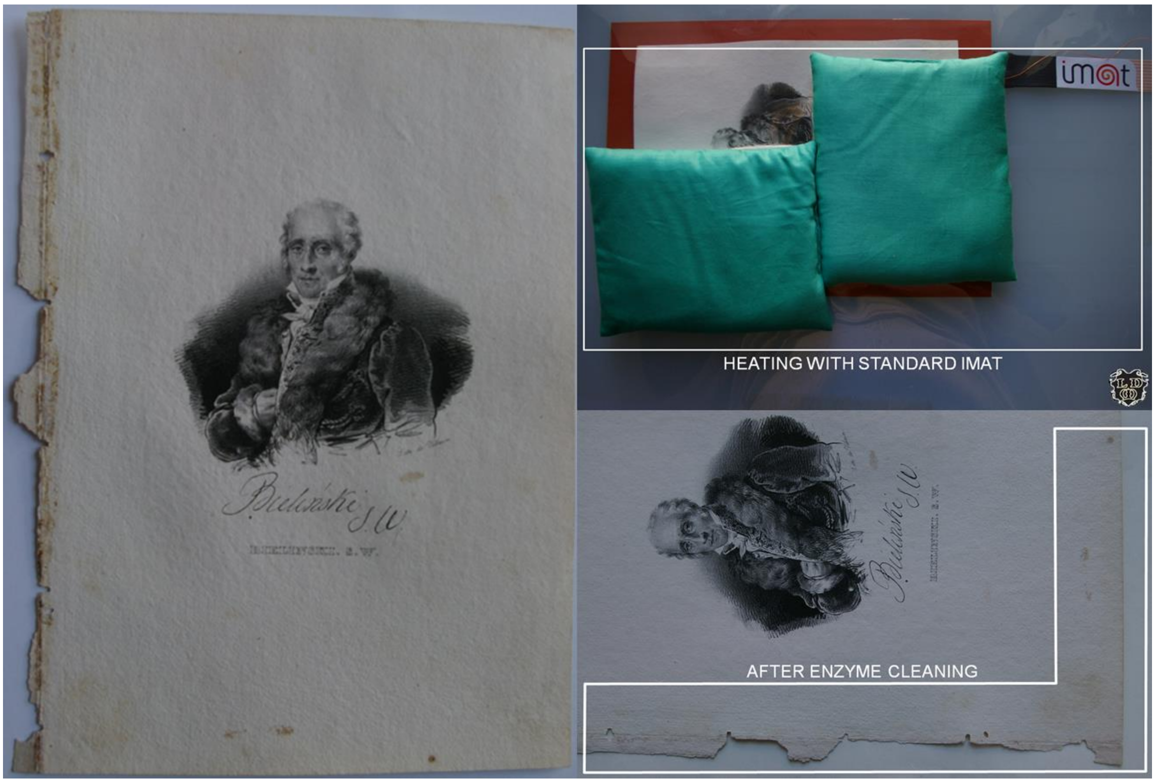

Figure 71 – Conservation of the Portrait of Bielinsky

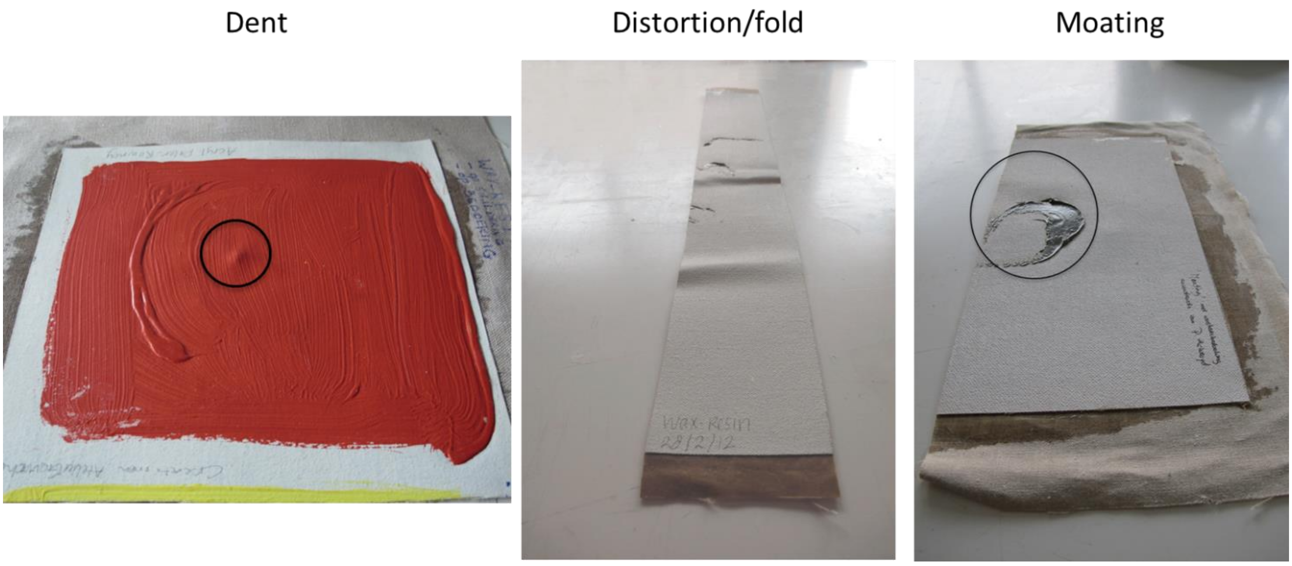

Figure 72 –Deformations in wax-resin lined paintings

Dent | Distortion/fold | Moating

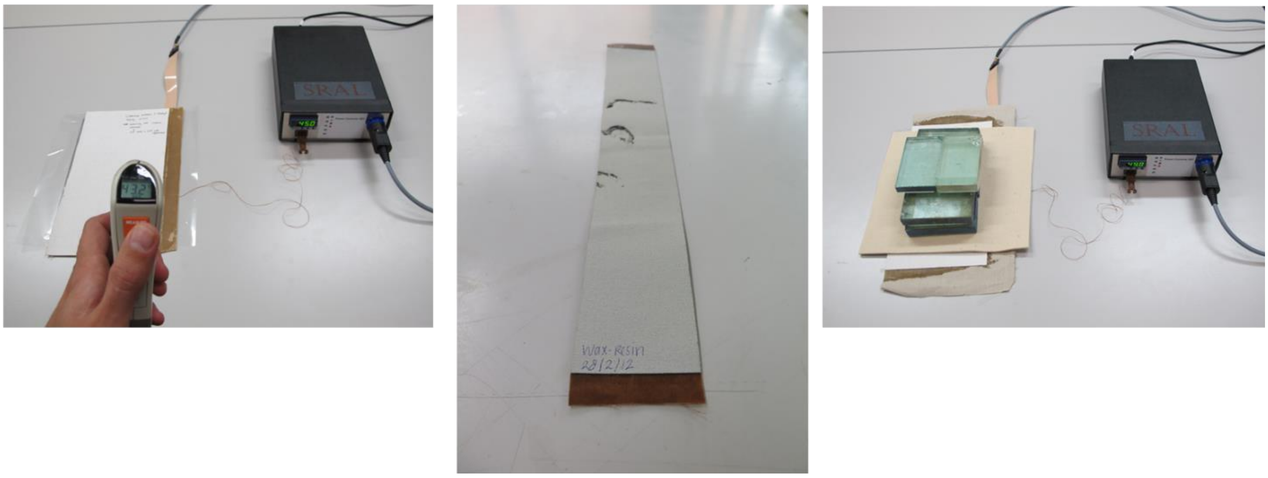

Figure 73 –Example of application of IMAT system on the wax-resin problem.