45th International Spring Seminar on Electronics Technology

Pressureless Direct Bonding of Au Metallized Substrate with Si Chips by Micro-Ag Particles

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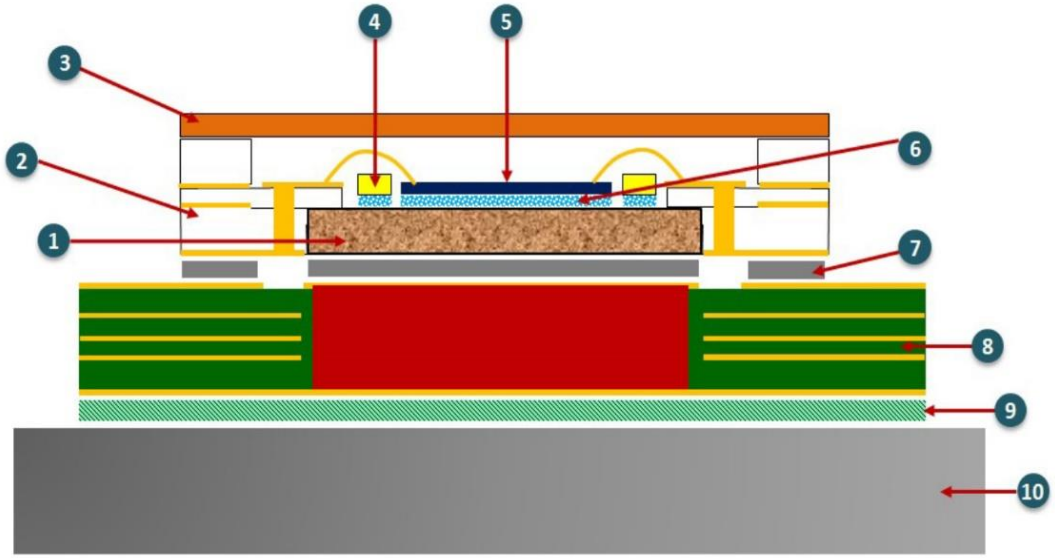
PRESENTATION OUTLINE

- Introduction
- Investigation methodology
- TIM AT2M –Optimization of sintering procedure
- Investigation of joining mechanisms of TIM AT2M paste
- Thermal measurements of (Au+paste+Si) joints
- Conclusions

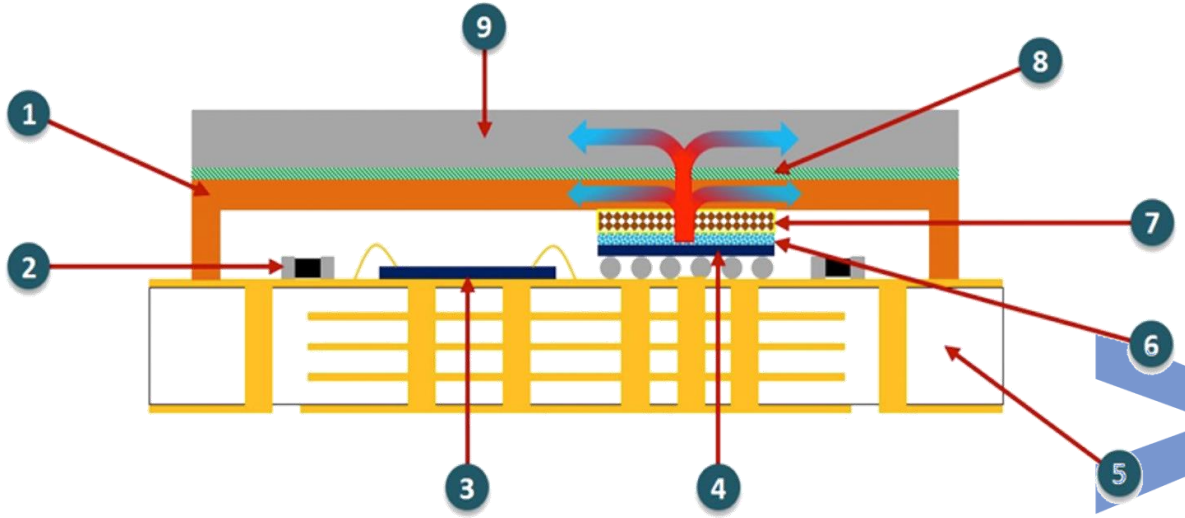
INTRODUCTION: WHAT IS HEATPACK

…DEVELOP THE NEXT GENERATION OF LOW THERMAL RESISTANCE PACKAGE

Package concept: RF package



Package concept: LF package



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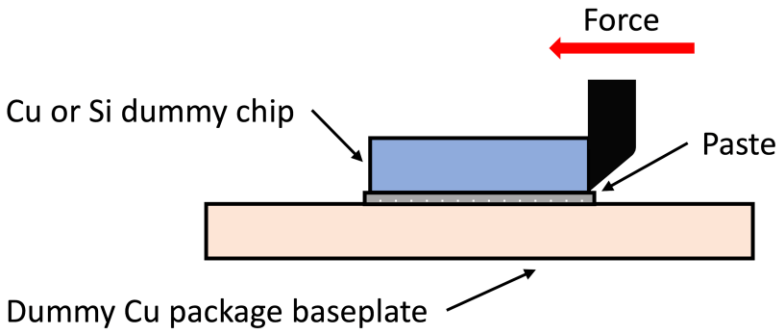
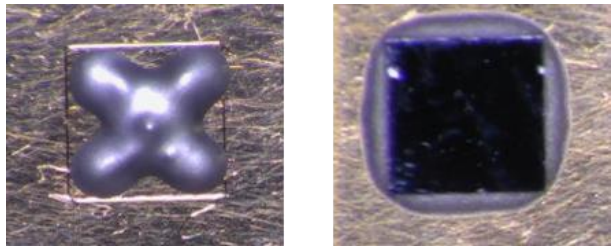
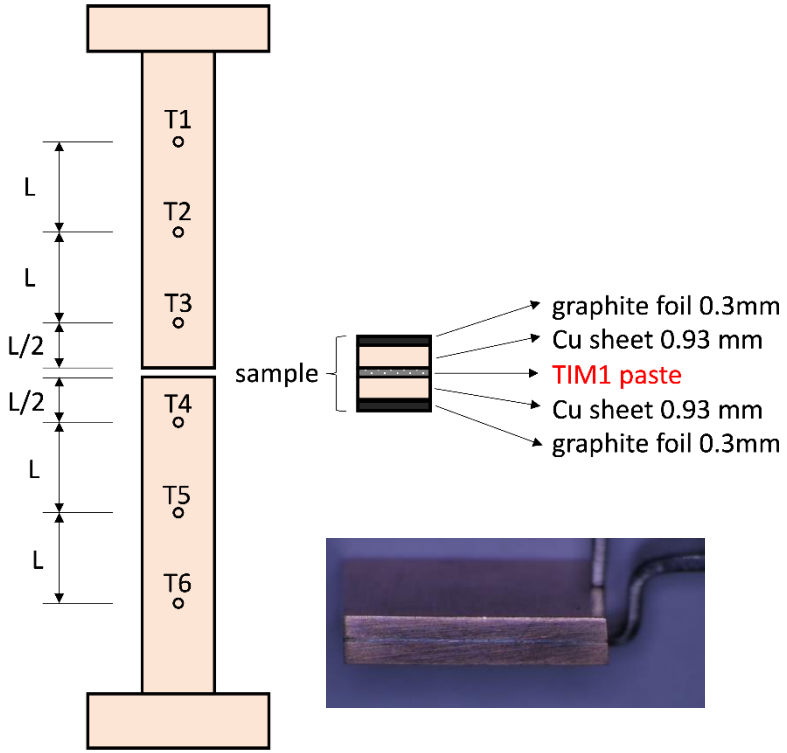
METHODS FOR MECHANICAL AND THERMAL PROPERTIES MEASUREMENTS







R_{th} bare Si Chip 0.52 mm

R_{th} interface:
Si chip – paste TIM AT2M

R_{th} TIM AT2M paste thickness 35 µm

R_{th} interface:
paste TIM AT2M – Cu sheet with Ni/Au

R_{th} Cu sheet 0.93 mm with Ni/Au

Min adhesion 5 MPa

TIM A2M paste: 92 wgt% (mixture Ag sphere size tens of micrometer + Ag flake micrometer size) + 8 wgt % resin

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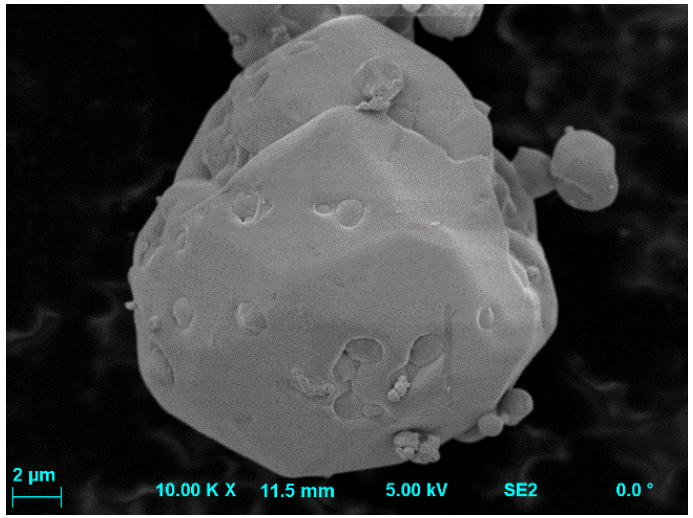
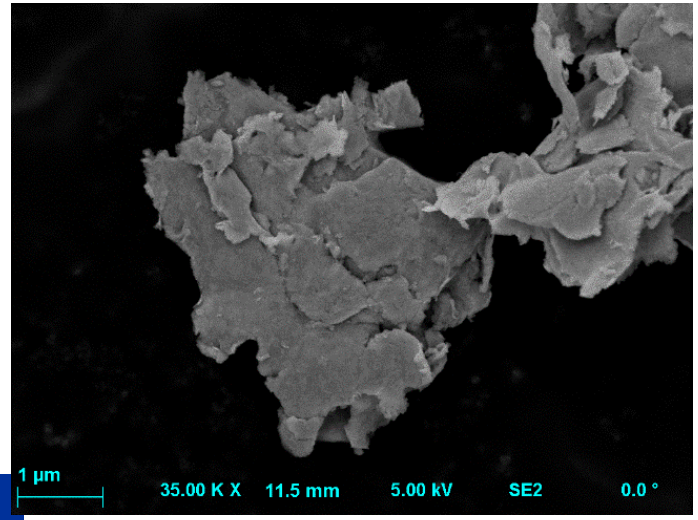
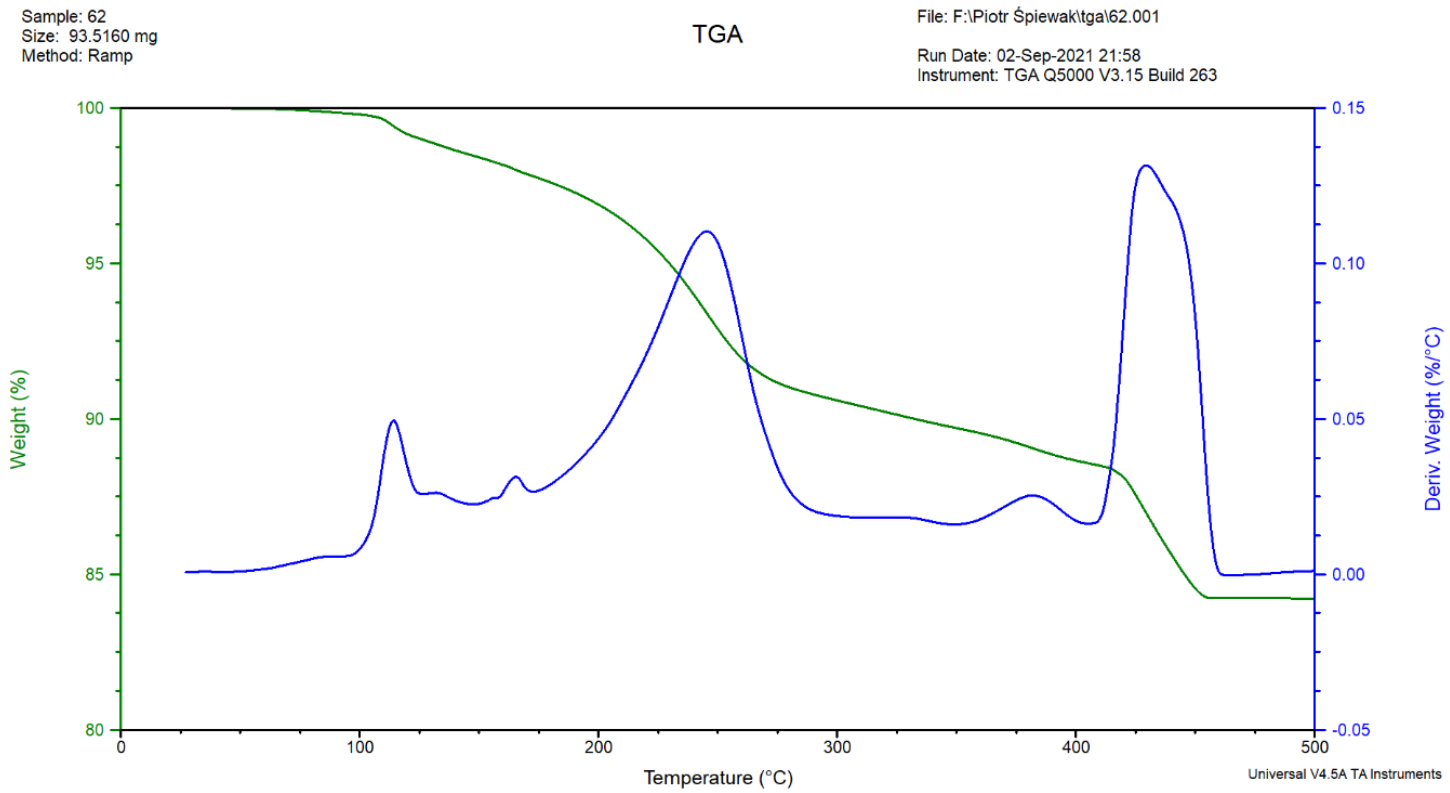
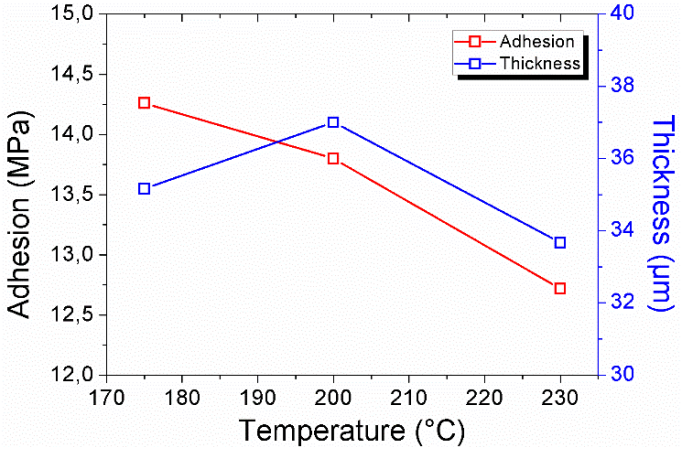
TIM AT2M PASTE

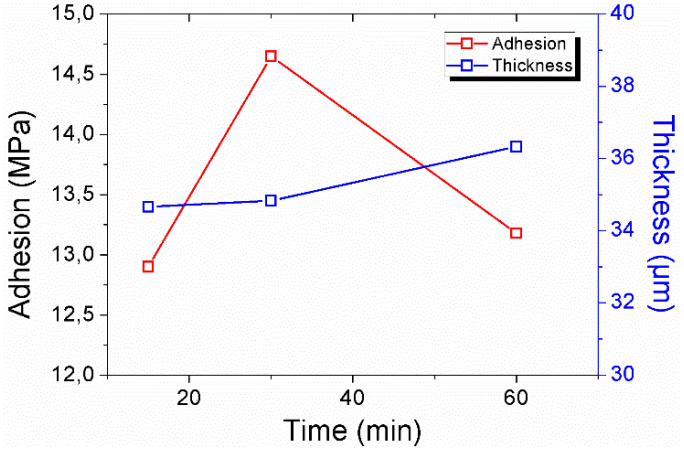


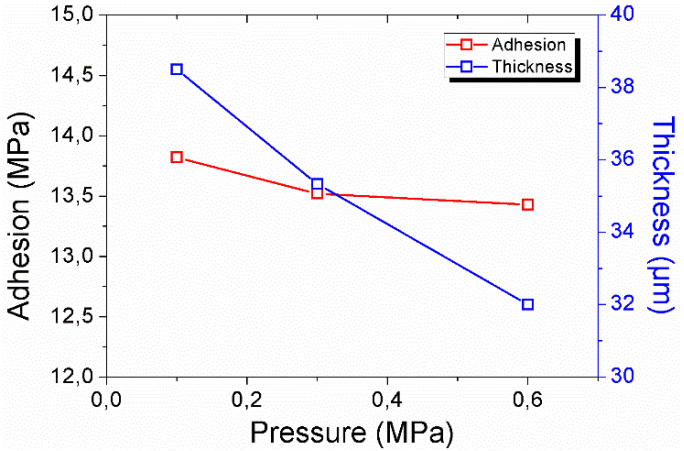


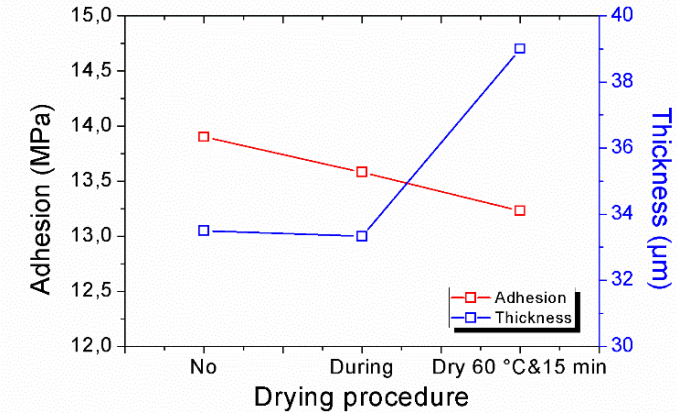


TIM AT2M, OPTIMIZATION SINTERING PROCEDURE





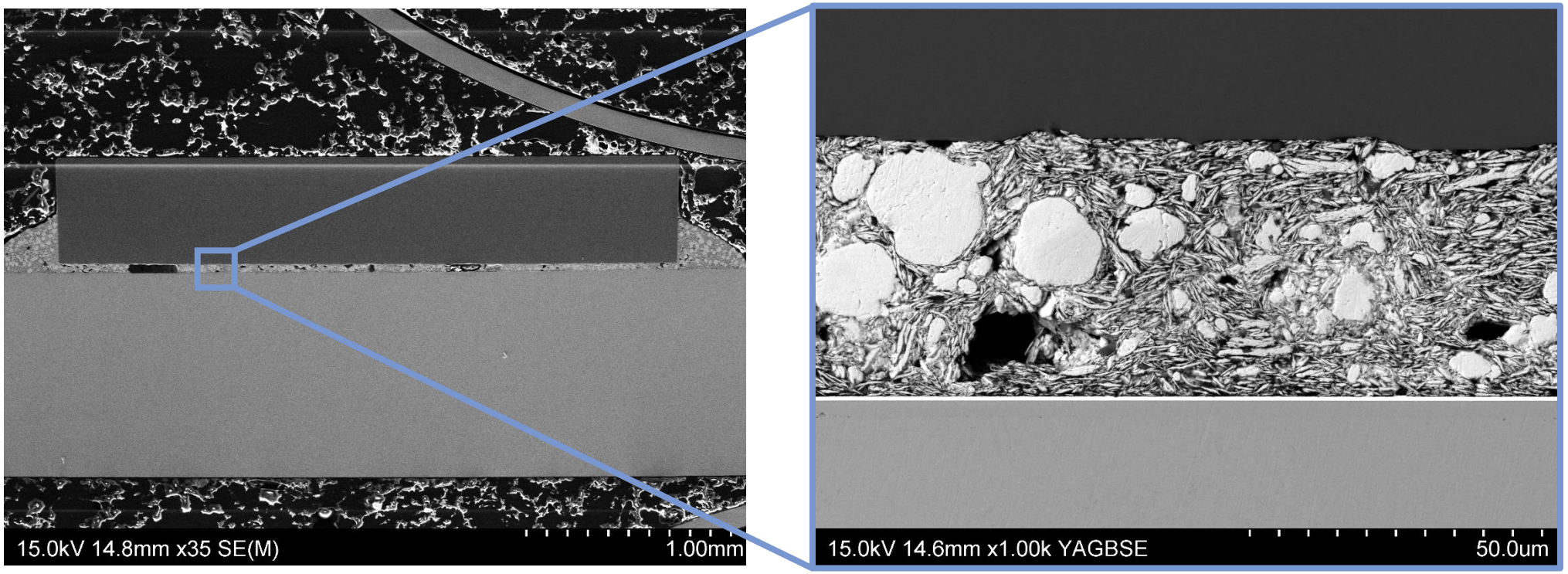




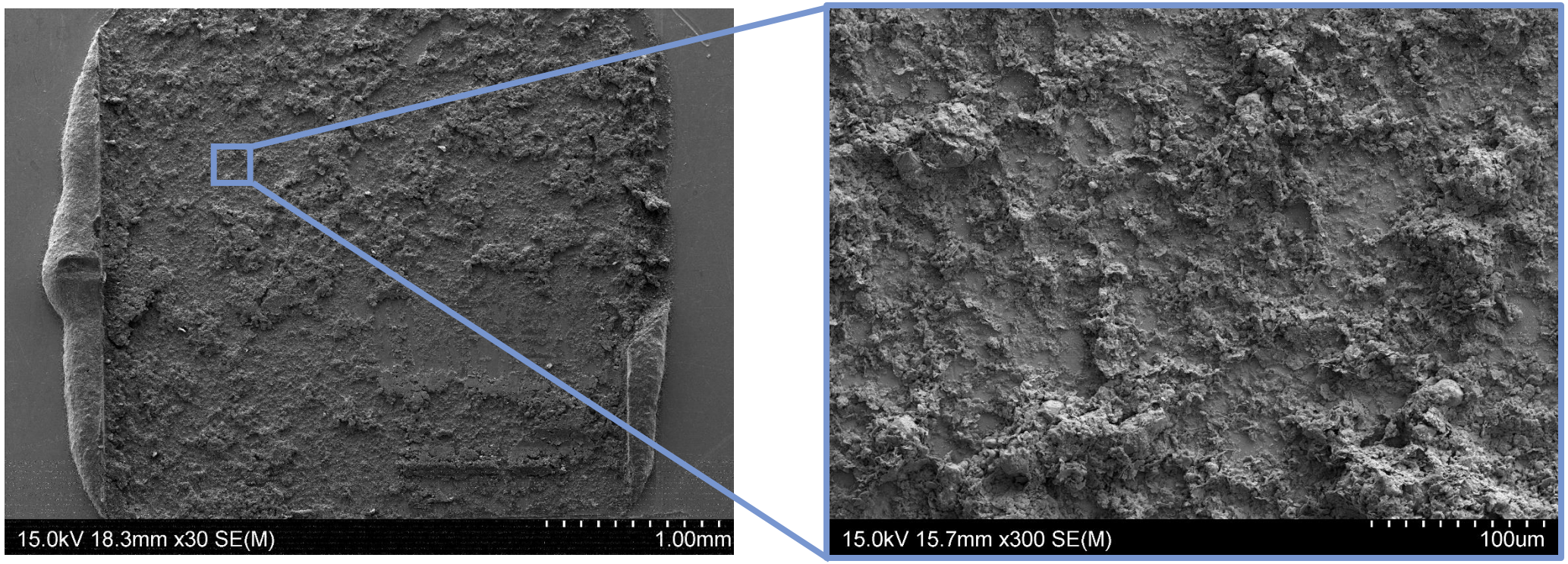
Optimization criteria:

- Adhesion better than 5 MPa
- Thickness in the range from 30 µm up to 60 µm

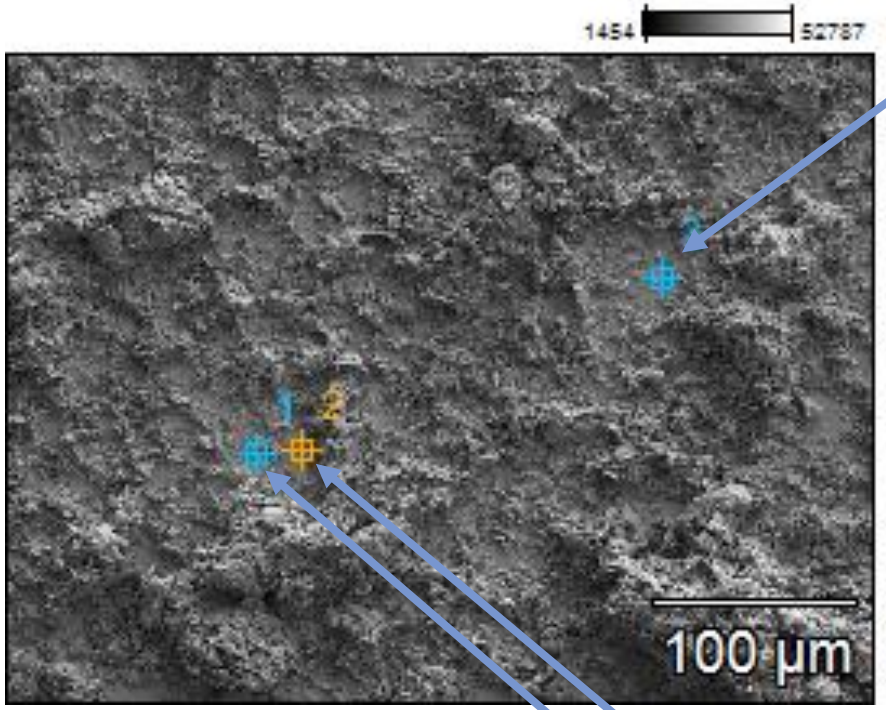
TIM AT2M, BARE SI, JOINT CROSS SECTION

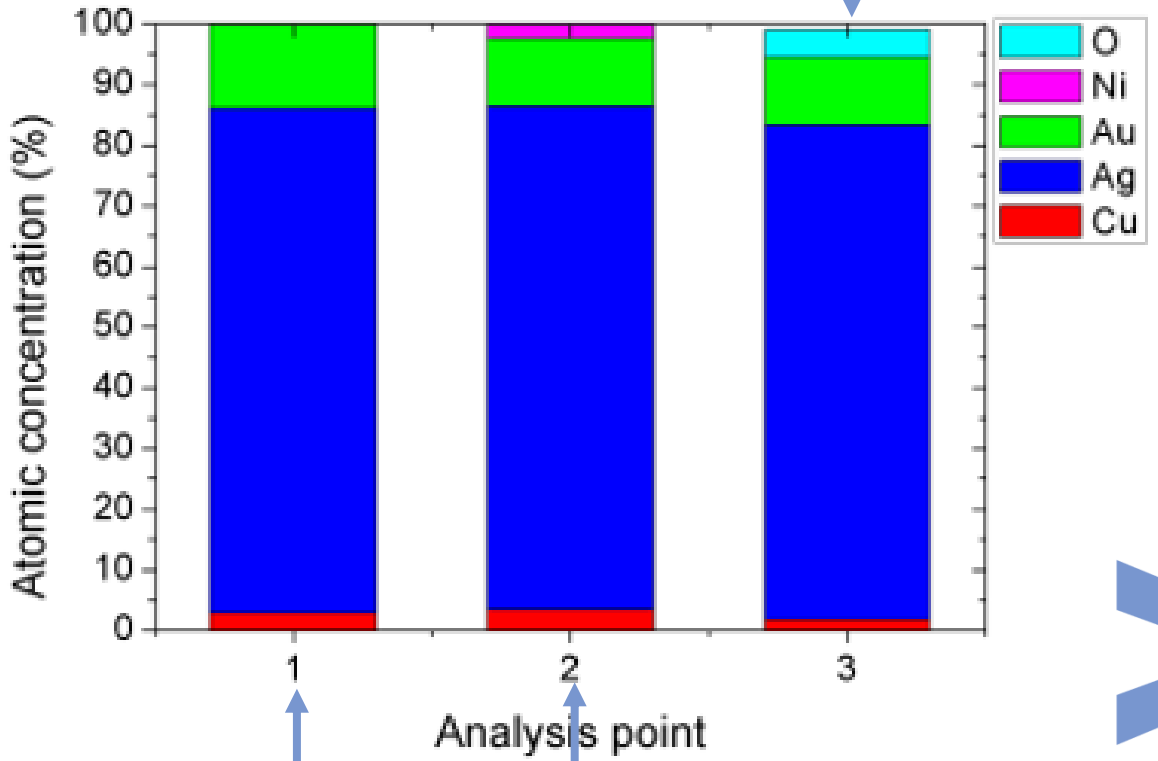


TIM AT2M, SEM IMAGE OF CU SUBSTRATE WITH NIAU METALLIZATION ATER CHIP REMOVAL



TIM AT2M, EDS Analysis of Interface Au on Substrate - Paste





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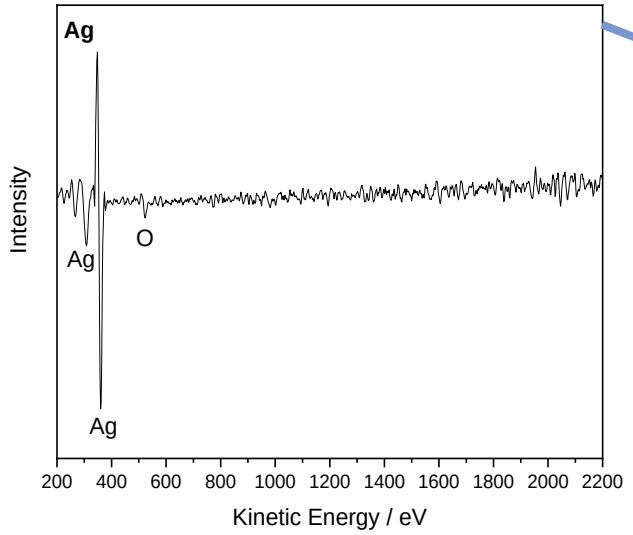
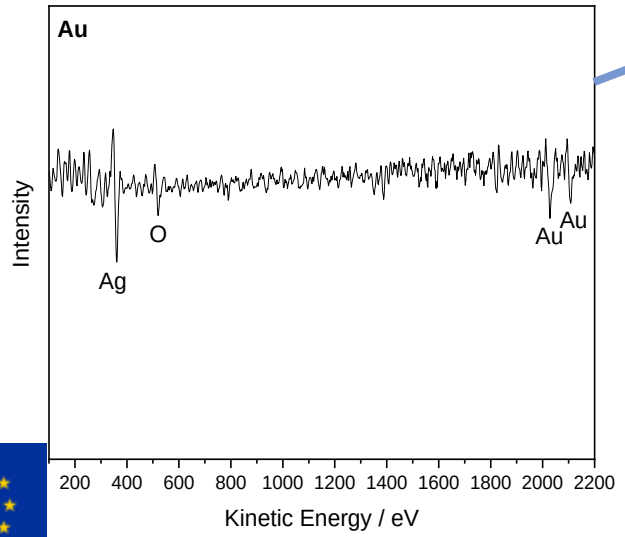
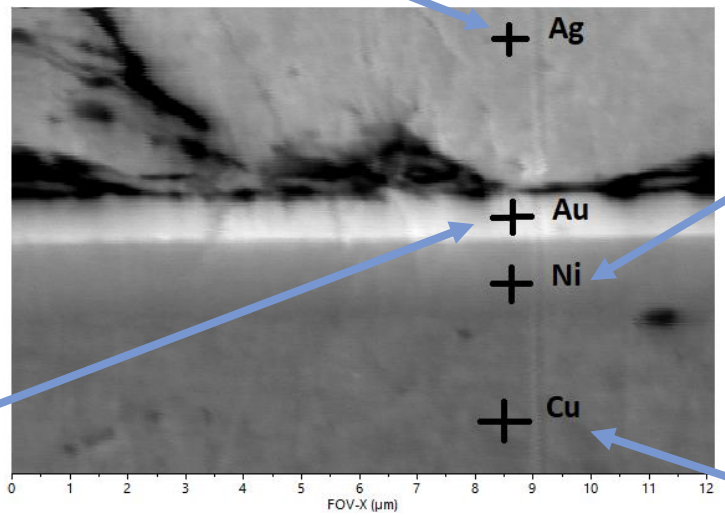
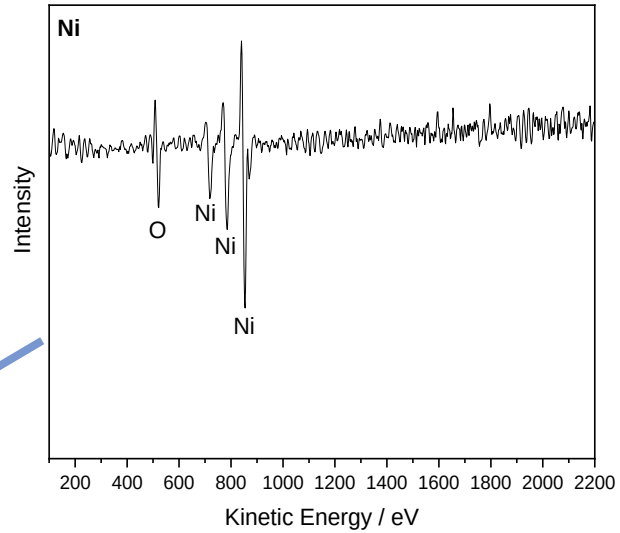
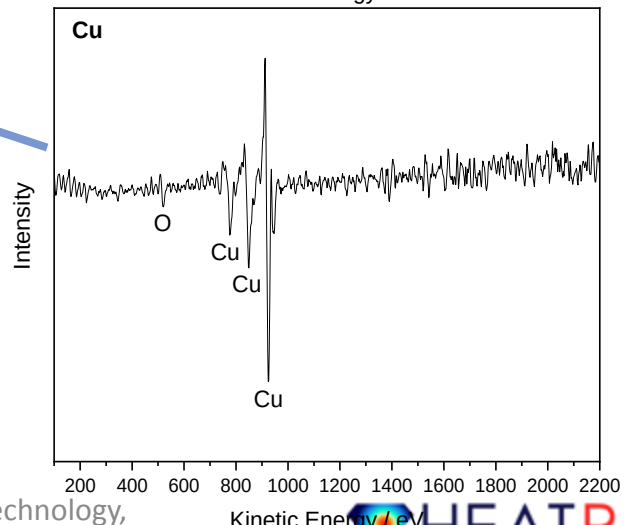
TIM AT2M, AES Analysis of Interface Cu with NiAu and Paste



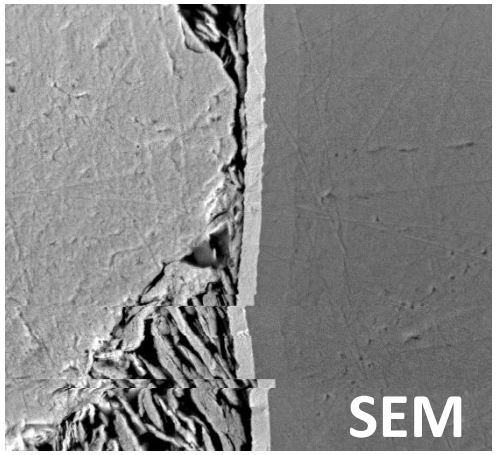


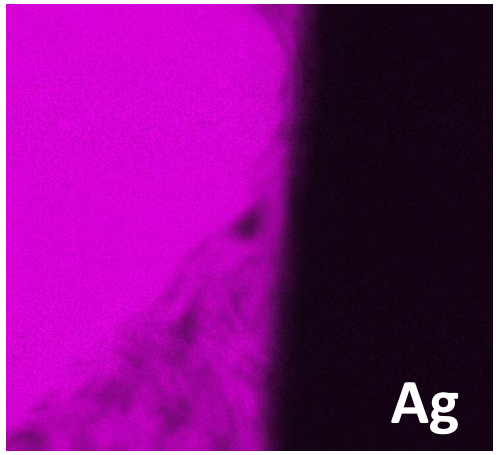


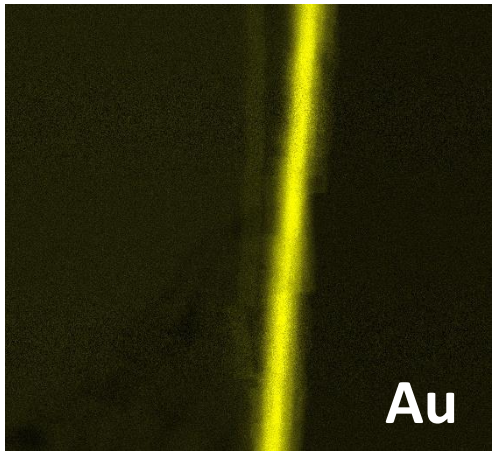


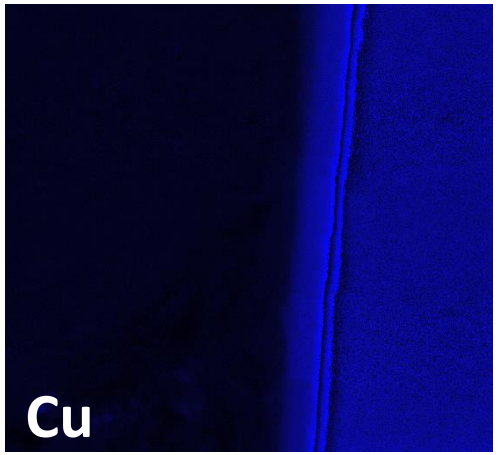


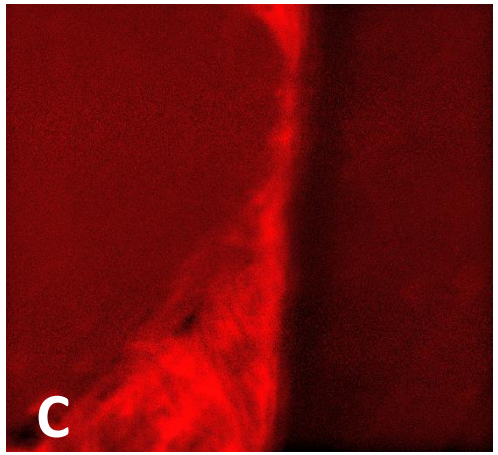
TIM AT2M, AES Analysis of Interface Cu with NiAu and Paste

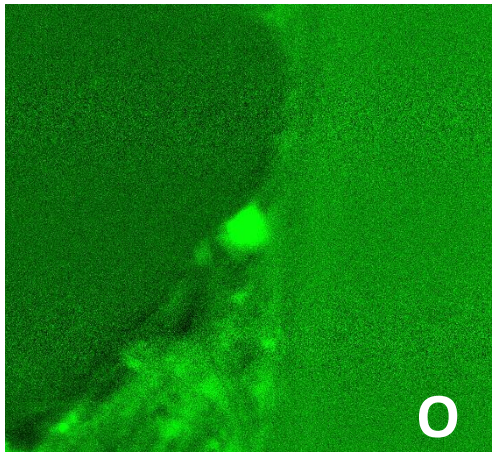




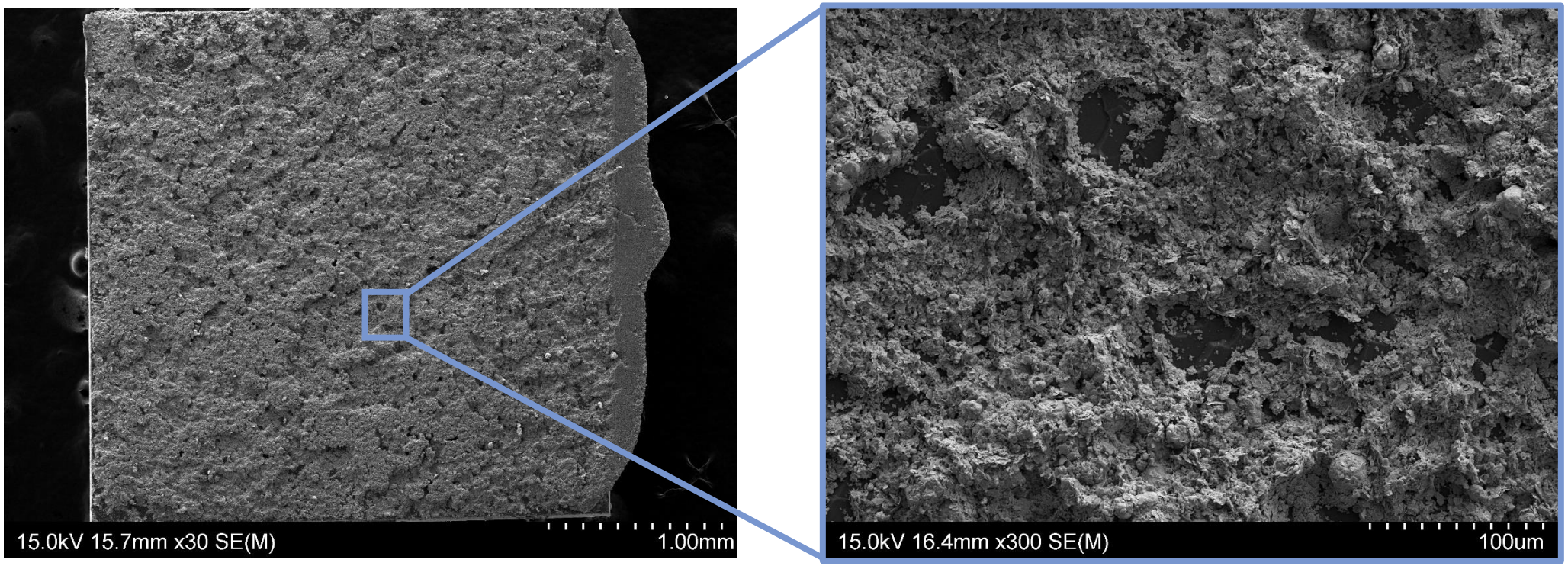




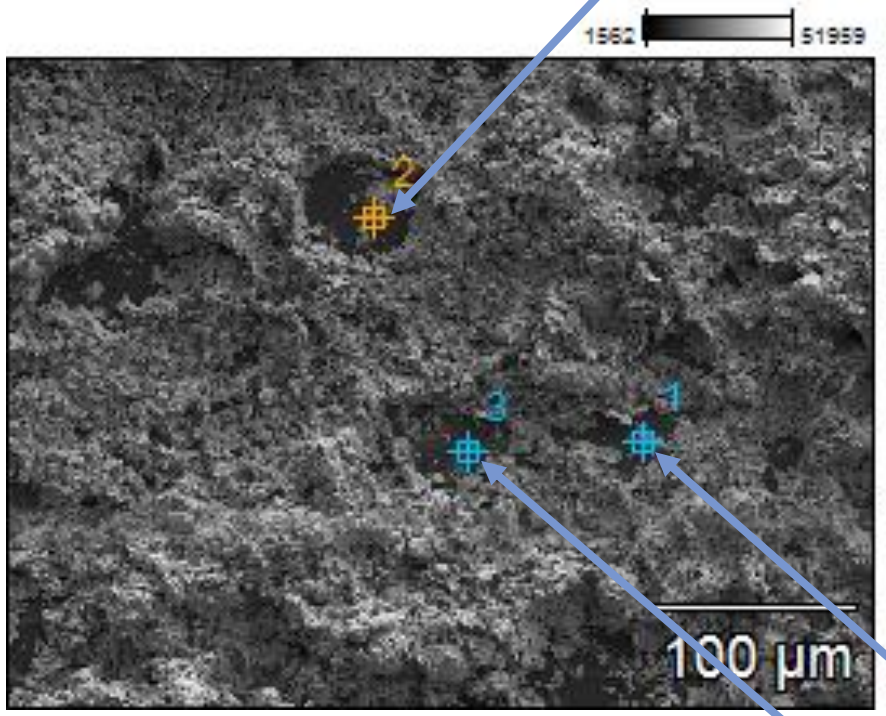


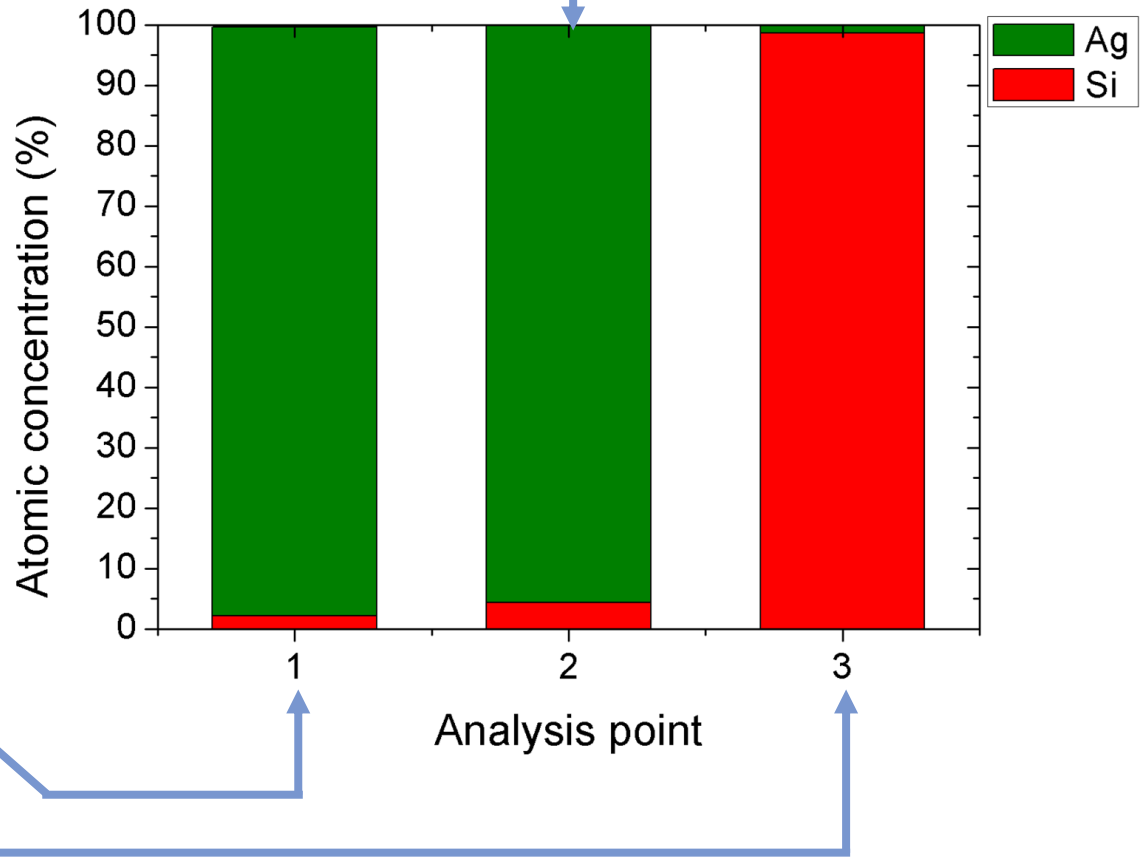


TIM AT2M, BARE SI, JOINT INTERFACE



TIM AT2M, EDS ANALYSIS ON CU SUBSTRATE WITH NIAU METALLIZATION





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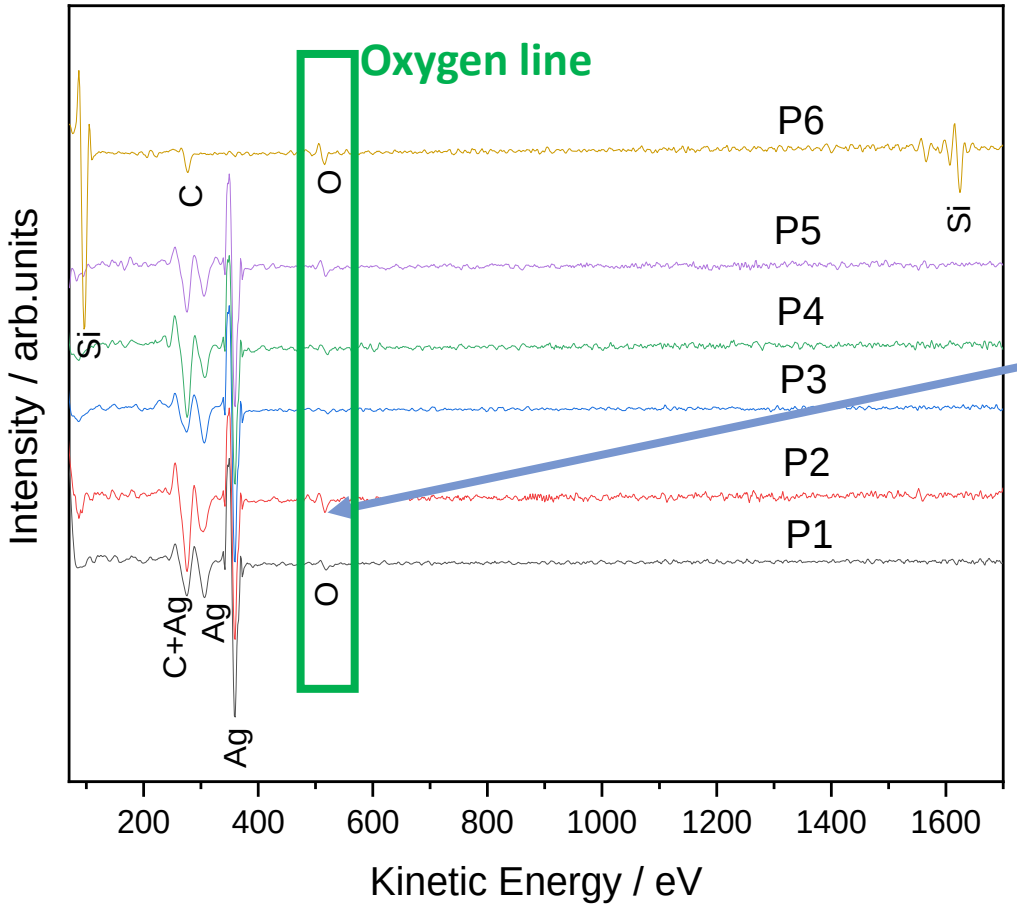
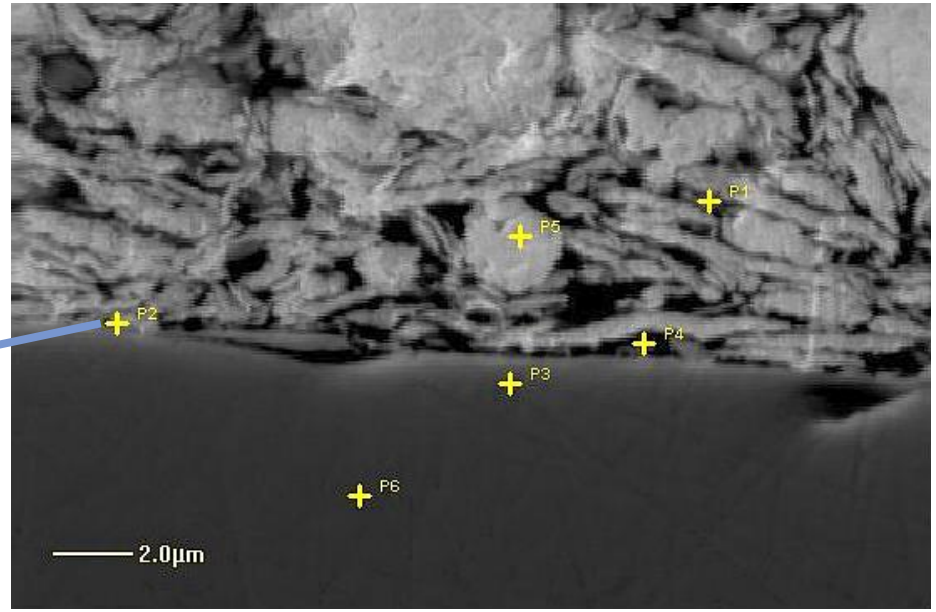
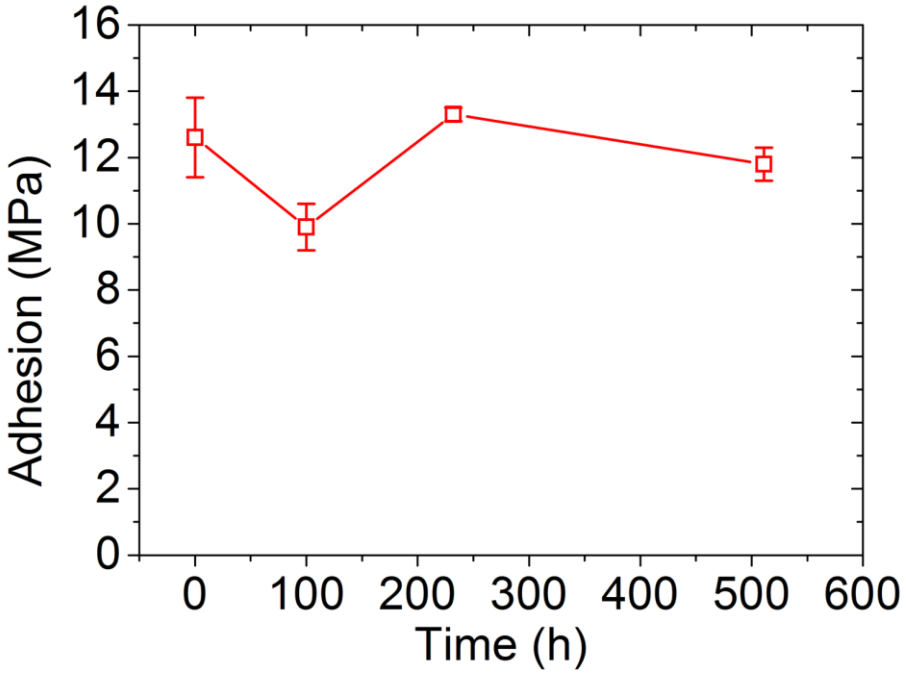
TIM AT2M, AES/XPS Analyse of Interface Si - Paste

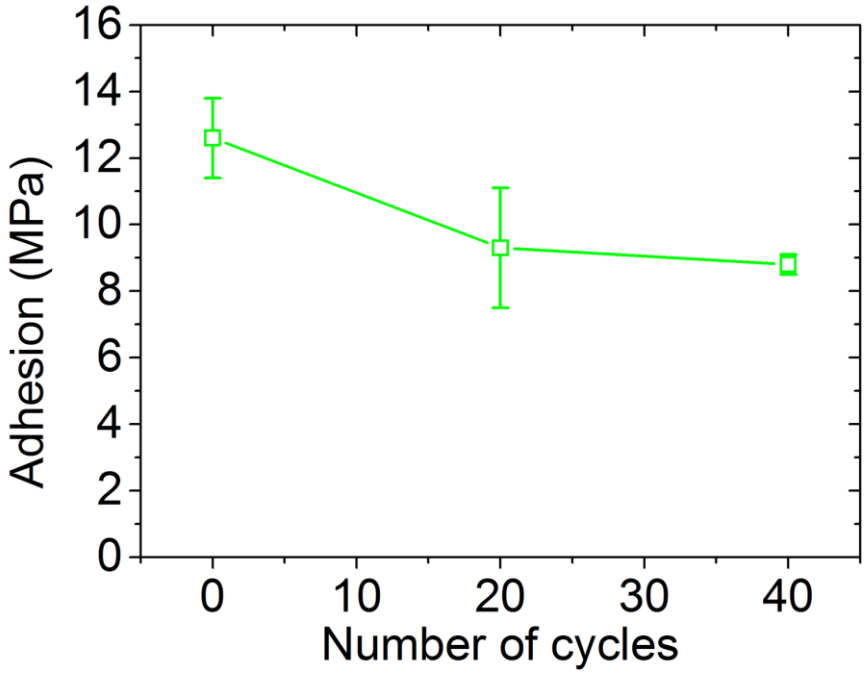




TIM AT2M, JOINT ADHESION AFTER TESTS

- Long temperature ageing at 125 °C for 500 h (red graph)
- Thermal cycles -25 °C to 100 °C (green graph)





No significant sample degradation observed for temperature and thermal cycles

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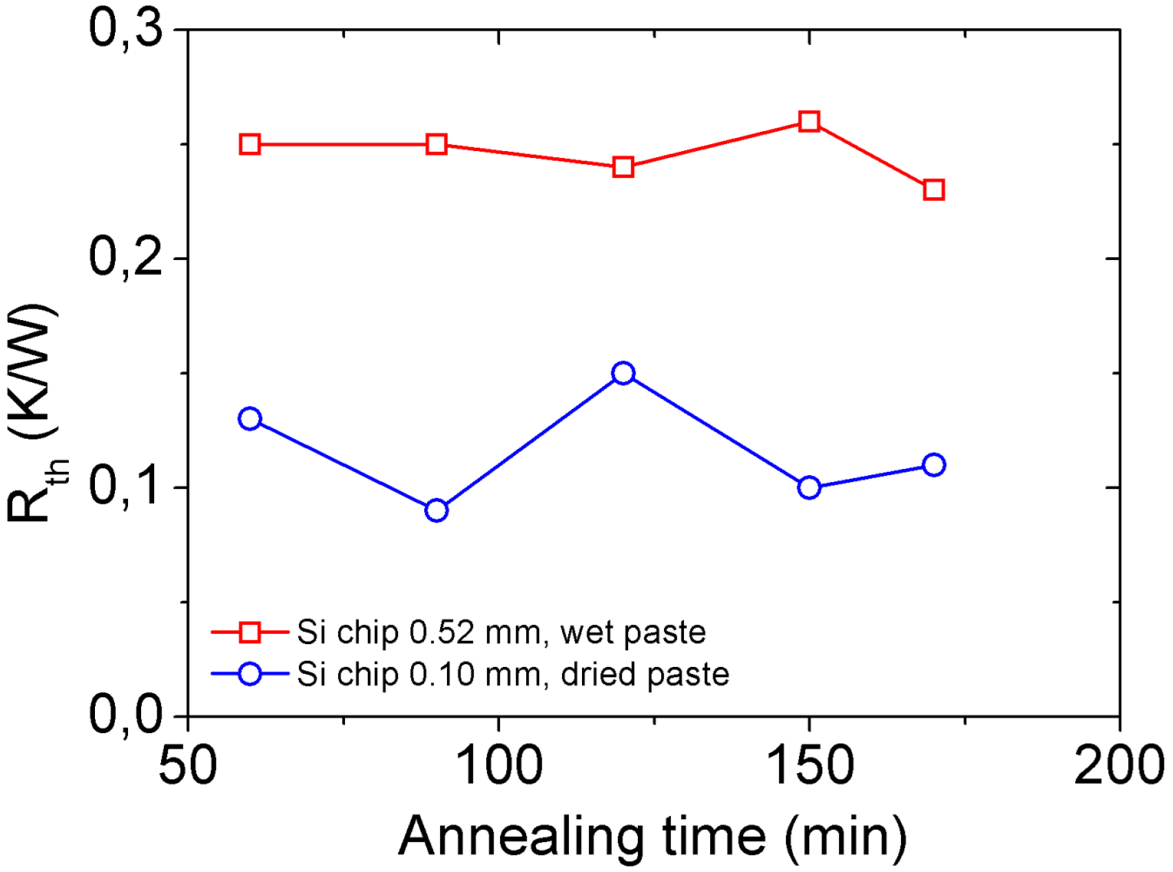
TIM AT2M, Joint Thermal Resistance (joint thickness 35 micrometer)



Red – 0.52 mm Si chip placed on the wet paste
Blue – 0.10 mm chip placed on the dried paste

For both methods TIM AT2M can be successfully applied as Thermal Interface Material for assembly processes

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CONCLUSIONS

- Resin content in the paste is responsible for good mechanical properties of joints created between bare Si and Ag-based TIM AT2M paste, oxygen presence is essential
- Resin content in the paste and small range diffusion between Ag and Au are responsible for good adhesion between Au metallization on substrate and Ag paste
- Thermal resistance of joints created between Au metallized Cu sheet and bare Si by TIM AT2M paste are less than 0.25 K/W, by pre-drying paste before sintering it can be reduced two times

ACKNOWLEDGEMENT

This project has received funding from the European Union's HORIZON 2020 research and innovation program under grant agreement No 821963.