Microelectronic adhesives: biobased resins and debondability to enable a sustainable future?

Dr Glenn Lamming

Senior Research Scientist

https://www.reform-project.eu

REFORM project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement Nº 101070255

We help to deliver, de-risk, and accelerate your concepts into successful products

Home to our national centres of excellence in...

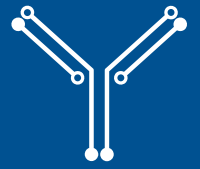
- Biologics
- Medicines Manufacturing
- Formulation
- Biotechnology
- Electronics
- Photonics






Our expertise in core capabilities

Biotechnology



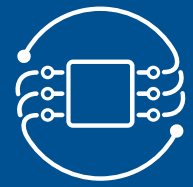
Biotherapeutics

Formulation and materials

Pharmaceutical processing

Photonics

Printed electronics



Flexible hybrid electronics

Digital

Supporting collaboration, investment, and grant applications...

Project scoping

Funding identification

Consortium building

Proposal development

Simplifying submission

Private investment

Project REFORM

"Address the environmental and sustainability challenges around conventional surface mounted and embedded functional electronics."

Rinted **E**lectronics **FOR** the circular econom**Y**

Sustainable debondable adhesives

Conductive inks

Flexible substrates

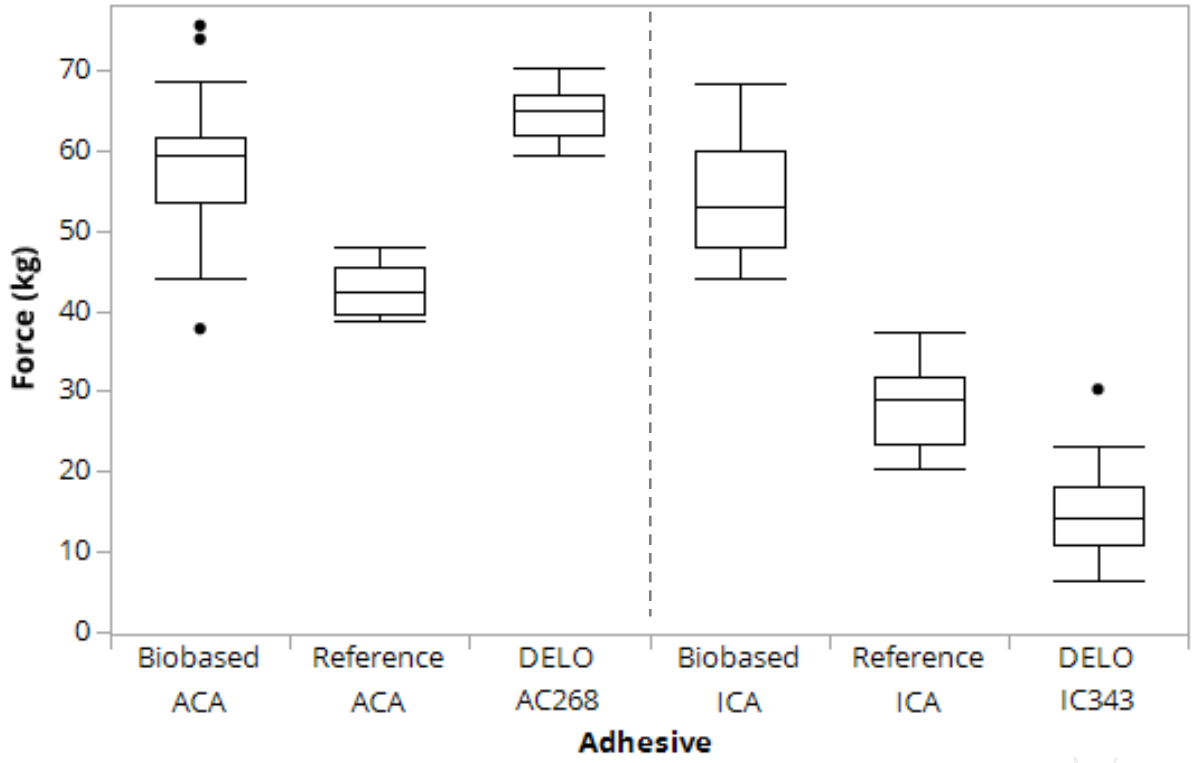
Integration into functional electronics systems

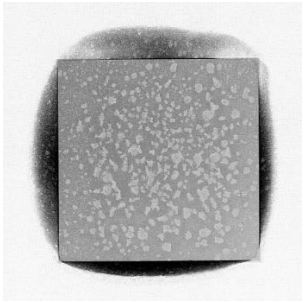
Material recovery and life cycle assessments

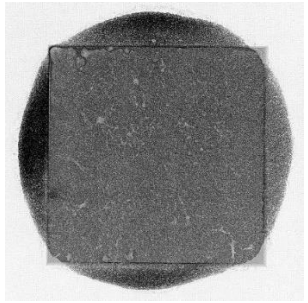
https://www.reform-project.eu

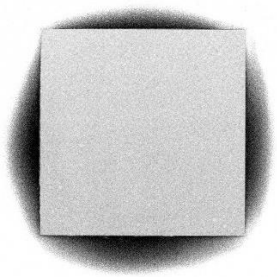
Biobased resins for microelectronic adhesives

- Exceptional adhesive strength could be realised with biobased epoxy resins
  - Good retention of strength under heating:
    - 60% compared to 65%
  - Good retention of strength after environmental conditioning (85% rH / 85 ºC, 72 hours):
    - 45% compared to 85%
- Challenges:
  - Resin purity – ionic content
  - Resin VOC - outgassing during adhesive cure
  - Reactive group equivalence
  - Biobased content
    - Striving for 100%?
    - LCA – are they more sustainable?



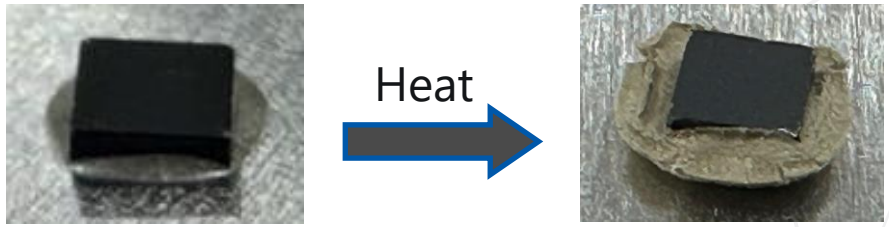






Debondable microelectronic adhesives

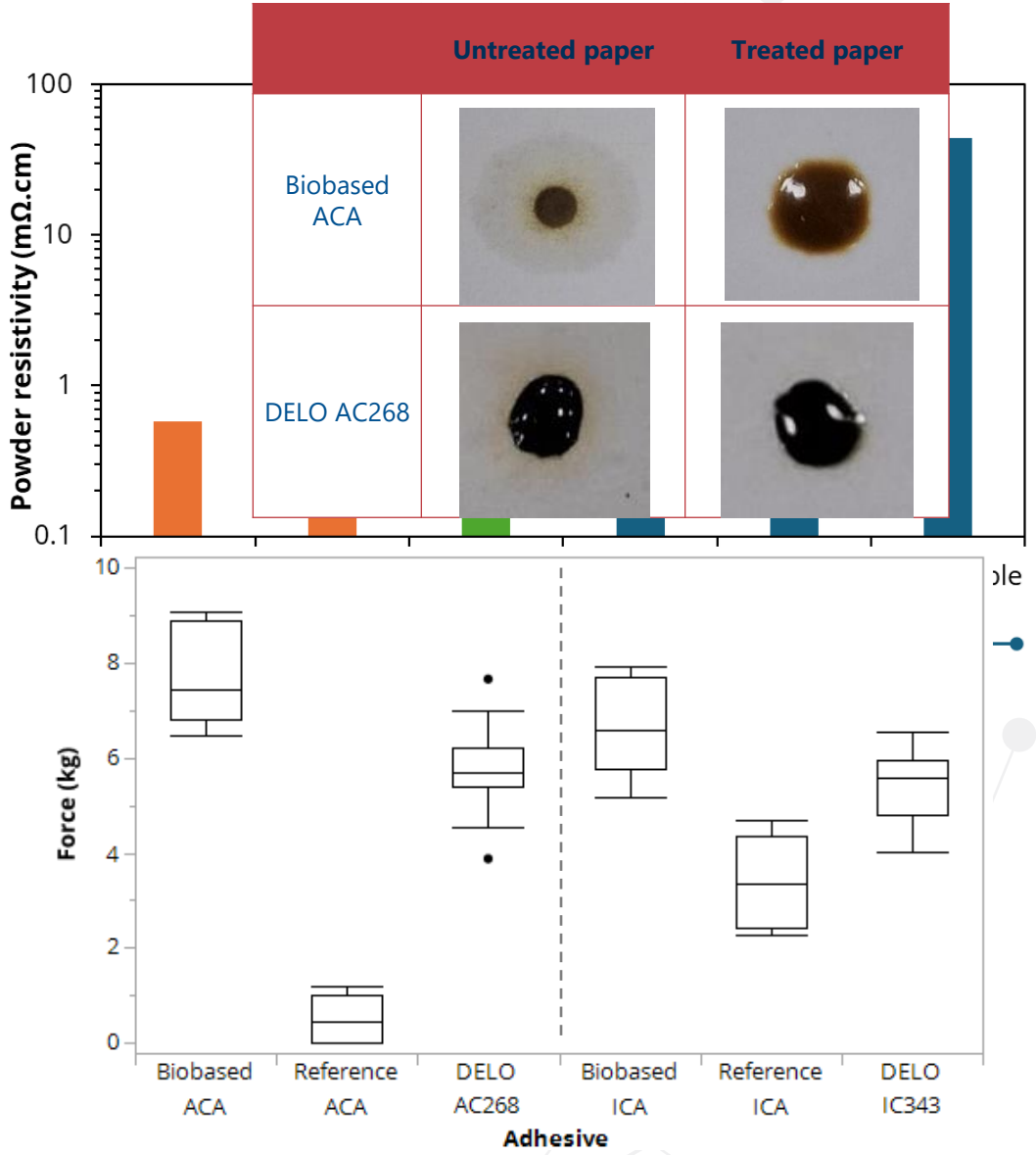
- High performance microelectronic adhesives are crosslinked thermosets:
  - Irreversible chemistries = nothing like solder
  - Removal requires solvents, pyrolysis, grinding, shredding etc.
- For REOFRM, CPI designed microelectronic adhesives to debond-on-demand using several strategies:
  - Expanding particles
  - Thermally softening resins
  - Chemically cleavable bonds
- There were challenges finding compatibility between:
  - Adhesive curing (exothermic) and debonding stimuli
  - Desired performance and debonding mechanism and/or stimuli
    - Mechanical properties
    - Temperature resistance
    - Dispense performance (rheology)



Green Chem., 2022, **24**, 36-61

Sustainable adhesives

- Commercially, conductivity is provided by metal powders e.g. silver/nickel
  - Up to 80% by weight of the adhesive (for ICA)
- Alternatives?
  - Carbons are possible in some applications, but they will require circuit design considerations.
  - Coated particles allowed CPI to reduce silver content by 70% whilst maintaining electrical conductivity.
- Bonding to sustainable substrates e.g. paper also carries challenges:
  - Not an easy substrate – resin bleed
    - Thankfully, not everything is an adhesive problem!
  - Die shear strength was low ..
    - Paper tears!
    - Do we really need an amazing adhesive for this?



Thank you

For more information visit **www.uk-cpi.com**

www.reform-project.eu

Dr Glenn Lamming
Senior Research Scientis

glenn.lamming@uk-cpi.com
+44 (0)1642 455 340

twitter.com/**ukCPI**

facebook.com/**ukCPI**

linkedin.com/company/**uk-CPI**

youtube.com/**ukCPI**

Let's innovate together
www.uk-cpi.com

cpi