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# Nature-Inspired Epoxy Resins: PinoDGE

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Session: Acrylates and resins

# INTRODUCTION | EPOXY RESINS

Epoxy chemicals are implicated in both occupational and non-occupational contact allergy.

**11.7 – 12.5%**

**0.9 – 2.3%**

Canelas, MM, et al. Contact Dermatitis (2010) 62: 55
Bangsgaard, N et al. Contact Dermatitis (2012) 67: 73

# OCCUPATIONAL CONTACT ALLERGY | EPOXY RESINS

Aircraft manufacturing

56%

Marble workers

45%

Painters

22.6%

Metal workers

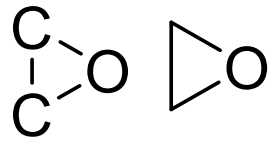
10.7%

Construction workers

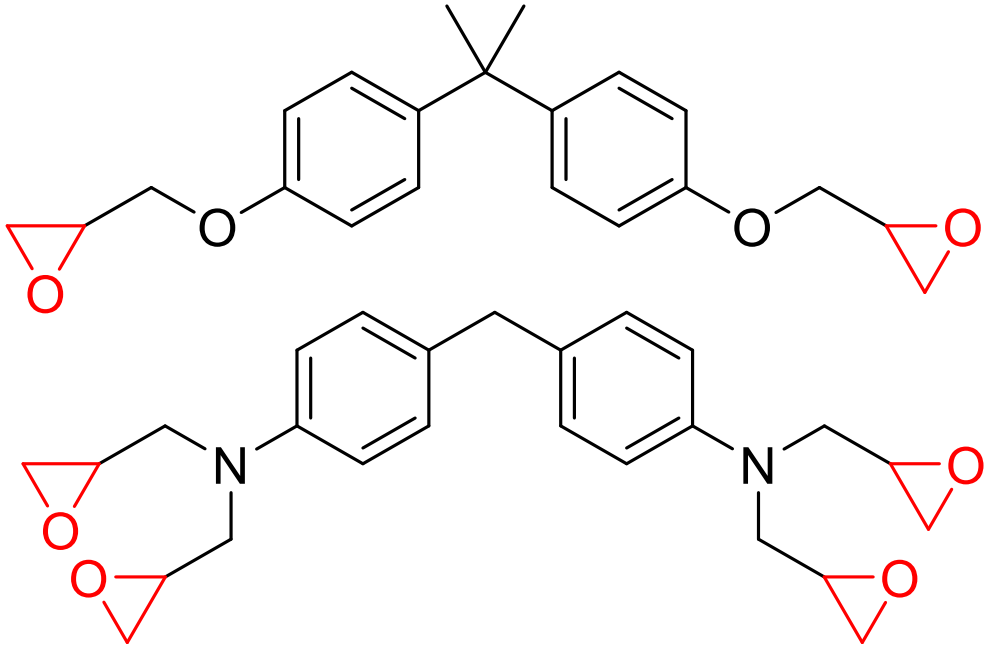
9.7%

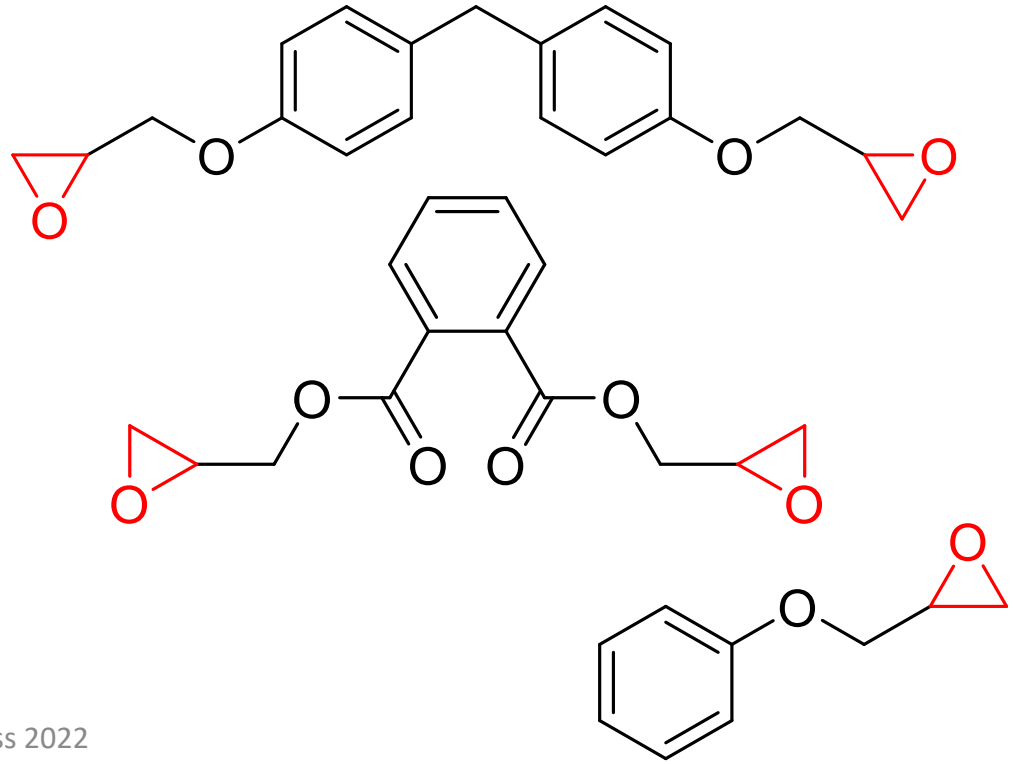
Higgins, C, Cahill, J, Jolanki, R, et al. (2018) Epoxy Resins. *In Kanerva's Occupational Dermatology (3rd edit)*

# INTRODUCTION | EPOXY RESINS



- Global market volume: 3.0 million tonnes per annum
- Allergenicity depends on the terminal epoxide group

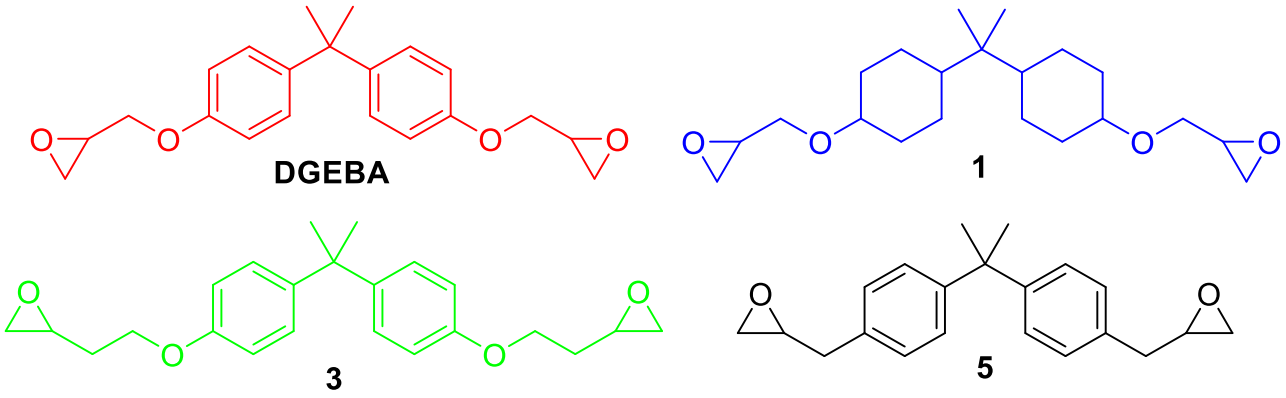




# AIM

Our aim is to develop epoxy resins that:

1. Have less skin sensitizing properties
2. Have excellent technical properties
3. Are derived from sustainable sources

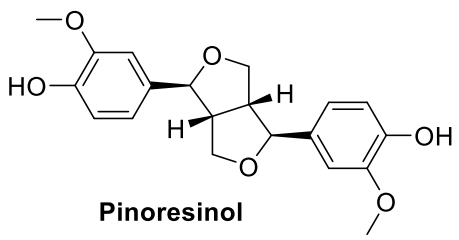




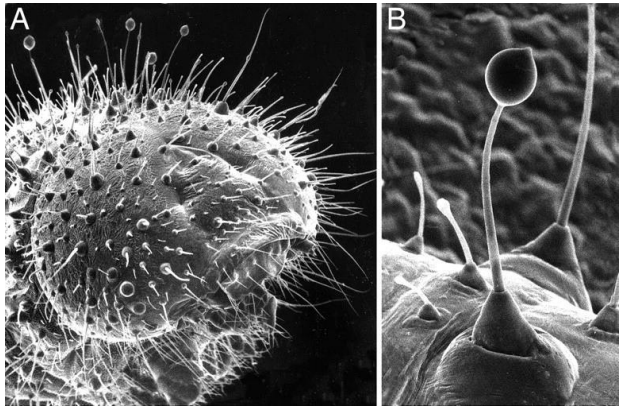
O'Boyle et al. *Chem. Res. Toxicol.* 2014, 27, 6, 1002–1010
*Royal Society of Chemistry. Polymers in liquid formulations*

# PINORESINOL

- A lignan found in many plant species, including *Forsythia*
- Also found in the secretions of a caterpillar, *Pieris rapae*



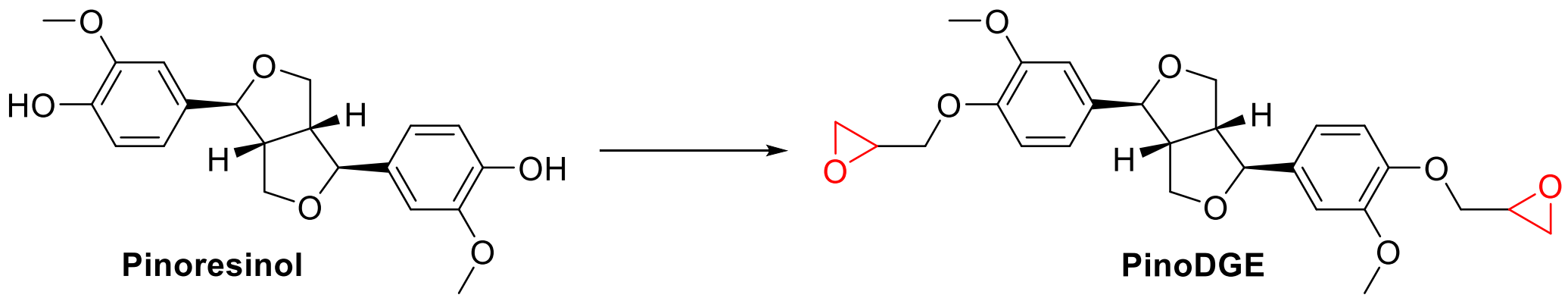
Pinoresinol






*https://www.pnas.org/doi/10.1073/pnas.0605921103*

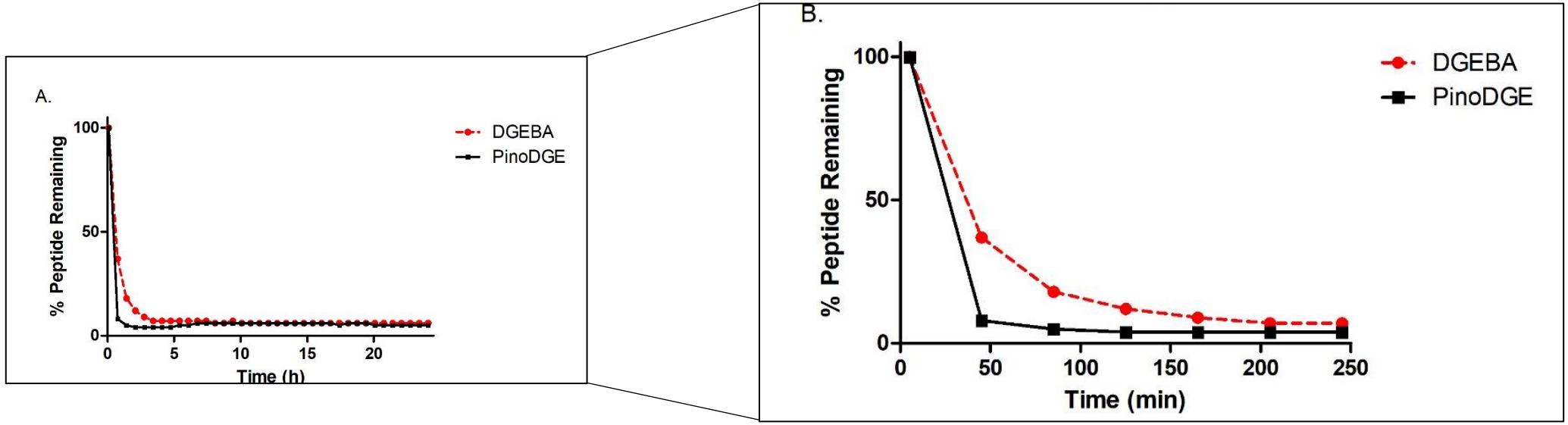
# PinoDGE | SYNTHESIS FROM PINORESINOL




*Reagents and conditions*: (±)-Epichlorohydrin (22 eq.), NaOH (4 eq.), EtOH, 80 °C, microwave irradiation, 40 min, **88 %**

# PinoDGE | PEPTIDE REACTIVITY

- Model peptide AcPHCKRM
  - Contains cysteine and histidine amino acids
- React with DGEBA or PinoDGE for 24 hours
- Measure reactivity by LC/MS



# PinoDGE | KeratinoSens ASSAY

| Compound | $I_{max}$ (fold induction) [b] | Classification[b] | $EC_{KS}1.5$ (µM)[c] | $EC_{KS}4.5$ (µM)[c] | Cytotoxicity $IC_{50}$ (µM)[d] |
|---|---|---|---|---|---|
| **DGEBA** | 13 | Sensitizer | 5.2 | 10 | 22 |
| **PinoDGE** | 246 | Sensitizer | 2.5 | 7.4 | 24 |

# PinoDGE | LLNA ASSAY

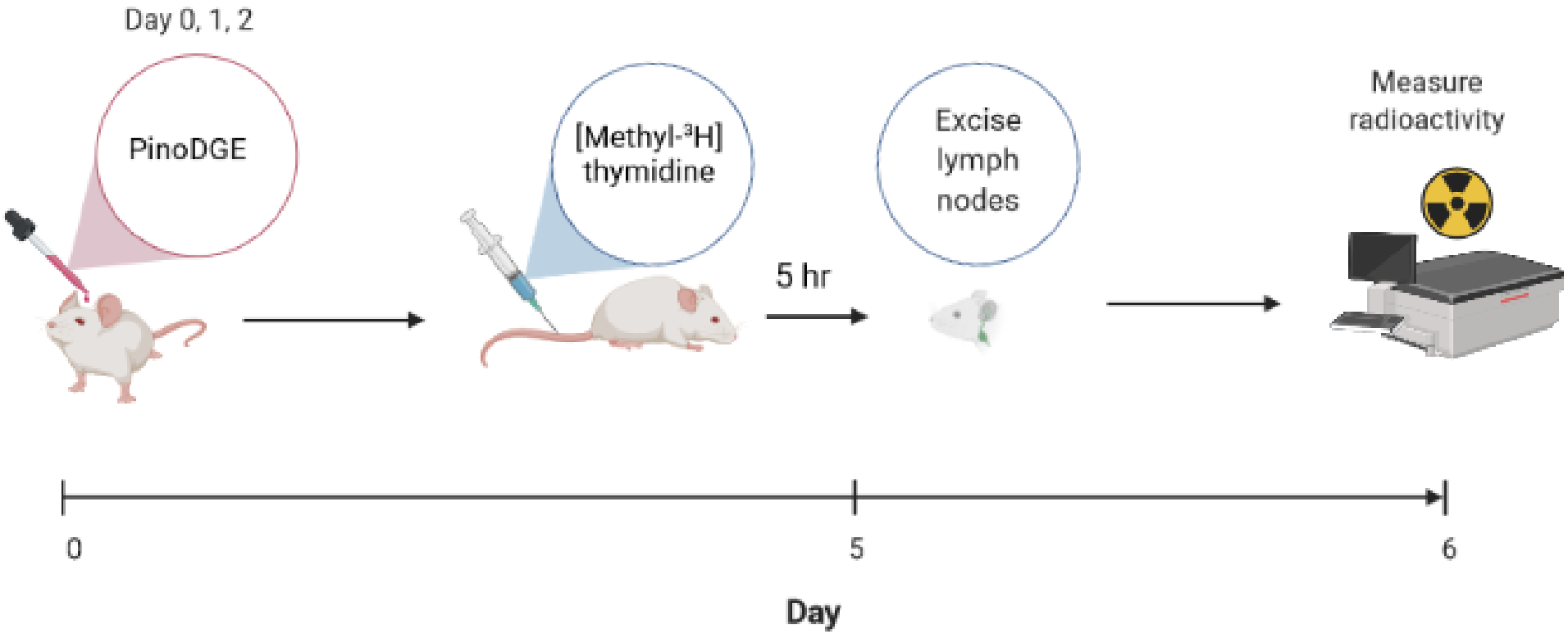



Image created using BioRender

# PinoDGE | LLNA ASSAY

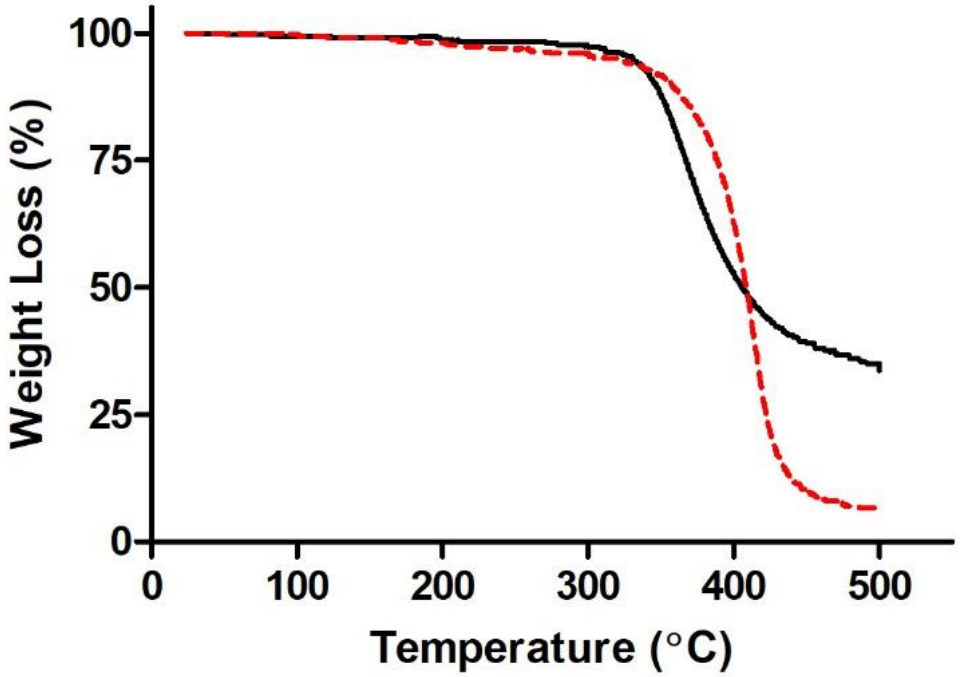
- PinoDGE was not classified as a skin sensitizer in the LLNA at concentrations up to 0.17 M
  - DGEBA EC3 = 0.036 M

**Table 2.** Detailed results from the LLNA of pinoresinol diglycidylether (PinoDGE)[a] in AOO 4:1 and in AOO 16:1.

| Solvent | Test concentration (% w/v) | Test concentration (M) | ($^3$H)thymidine incorporation (dpm/lymph node) | SI | EC3 (% w/v) | EC3 (M) |
|---|---|---|---|---|---|---|
| AOO 4:1 | Control | | 298 | | n. a[b] | n. a[b] |
| | 0.10 | 0.0021 | 280 | 0.94 | | |
| | 1.0 | 0.021 | 368 | 1.23 | | |
| | 2.5 | 0.053 | 166 | 0.56 | | |
| | 3.0 | 0.064 | 325 | 1.09 | | |
| | 5.0 | 0.11 | 327 | 1.10 | | |
| AOO 16:1 | Control | — | 248 | — | n. a[b] | n. a[b] |
| | 2.0 | 0.043 | 130 | 0.52 | | |
| | 4.0 | 0.085 | 180 | 0.73 | | |
| | 6.0 | 0.13 | 195 | 0.79 | | |
| | 8.0 | 0.17 | 480 | 1.94 | | |
| | 10[c] | 0.21[c] | 180 | 0.73 | | |

# PinoDGE | TECHNICAL PROPERTIES

- Thermogravimetric analysis
- Initial decomposition temperature
  - PinoDGE: 338 °C
  - DGEBA: 358 °C




Thermogravimetric thermograms showing % weight loss at increasing temperatures of epoxy resins based on different ERMs in N2. DGEBA and PinoDGE. N=3.

# SUMMARY | FUTURE WORK

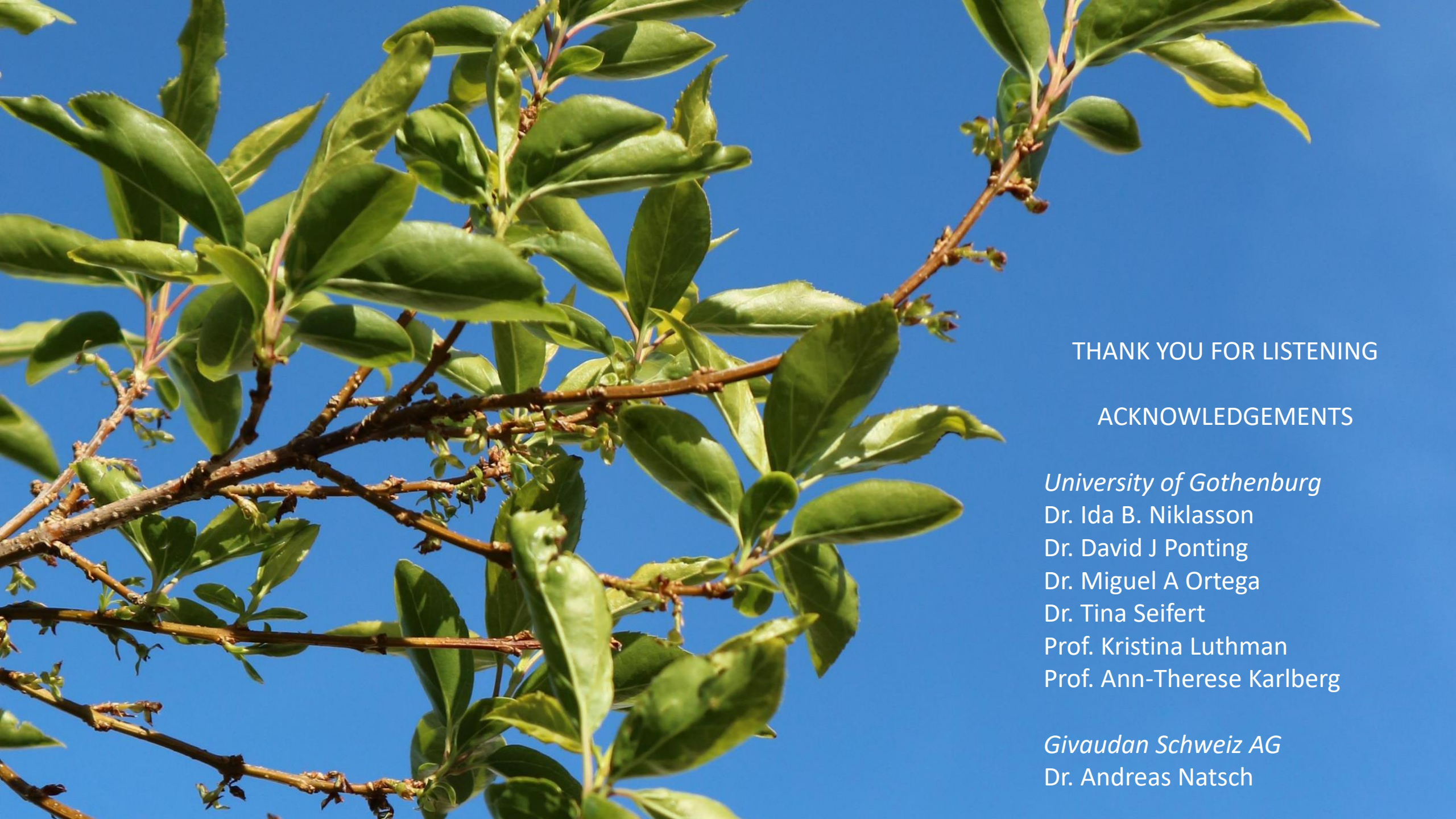
Epoxy resins that:

✓Have less skin sensitizing properties

- Have excellent technical properties*

✓Are derived from sustainable sources

  - Investigate a wider range of plant-derived material



THANK YOU FOR LISTENING

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