

# THE POWER OF NADES

## BOOSTING ENZYME STABILITY TOWARDS THERMAL DEGRADATION

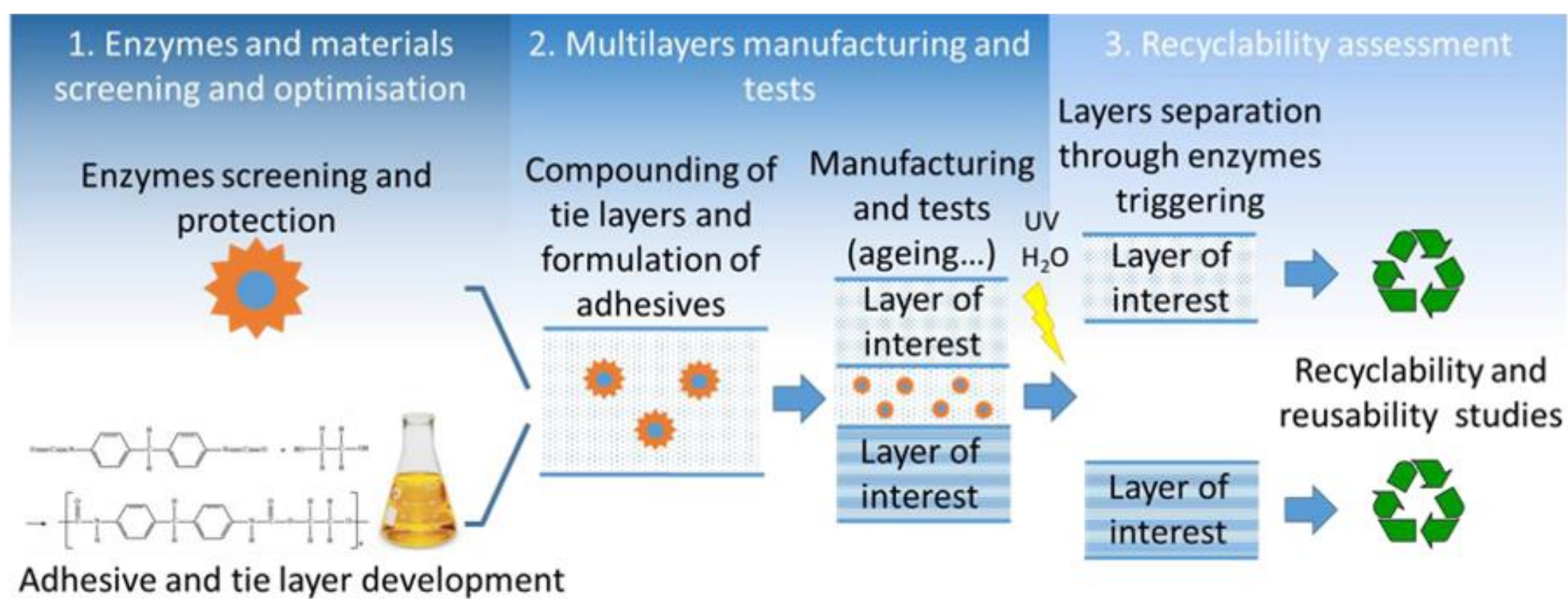
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### TERMINUS PROJECT



TERMINUS aims at unlocking the recycling of multi-layer packaging via a range of **smart enzyme-containing polymers** with triggered intrinsic self-biodegradation properties

To be feasible, such approach has to count on "tailored" enzymes, able to cope with the "extreme" conditions, especially **high temperature**, applied during material processing

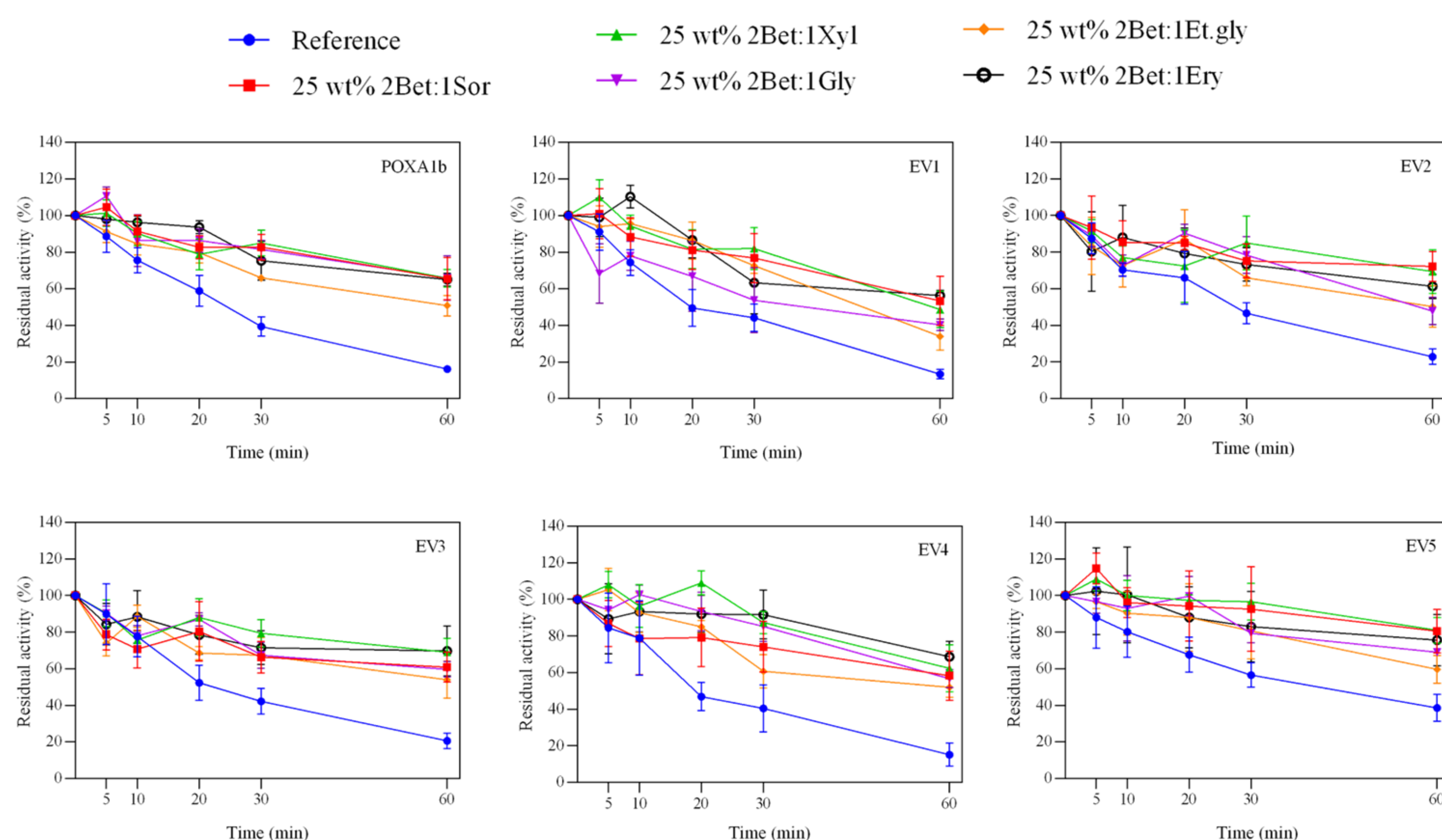
### LACCASES

**POXA1b** and 5 variants with wide range stability and activity (pH 3–9 and 25–65 °C)  
 Multi-copper-containing oxidoreductases used in a wide range of sectors, from the **textile** to the **pulp** and **paper** industry, through the applications in **food** industry and **bioremediation** processes

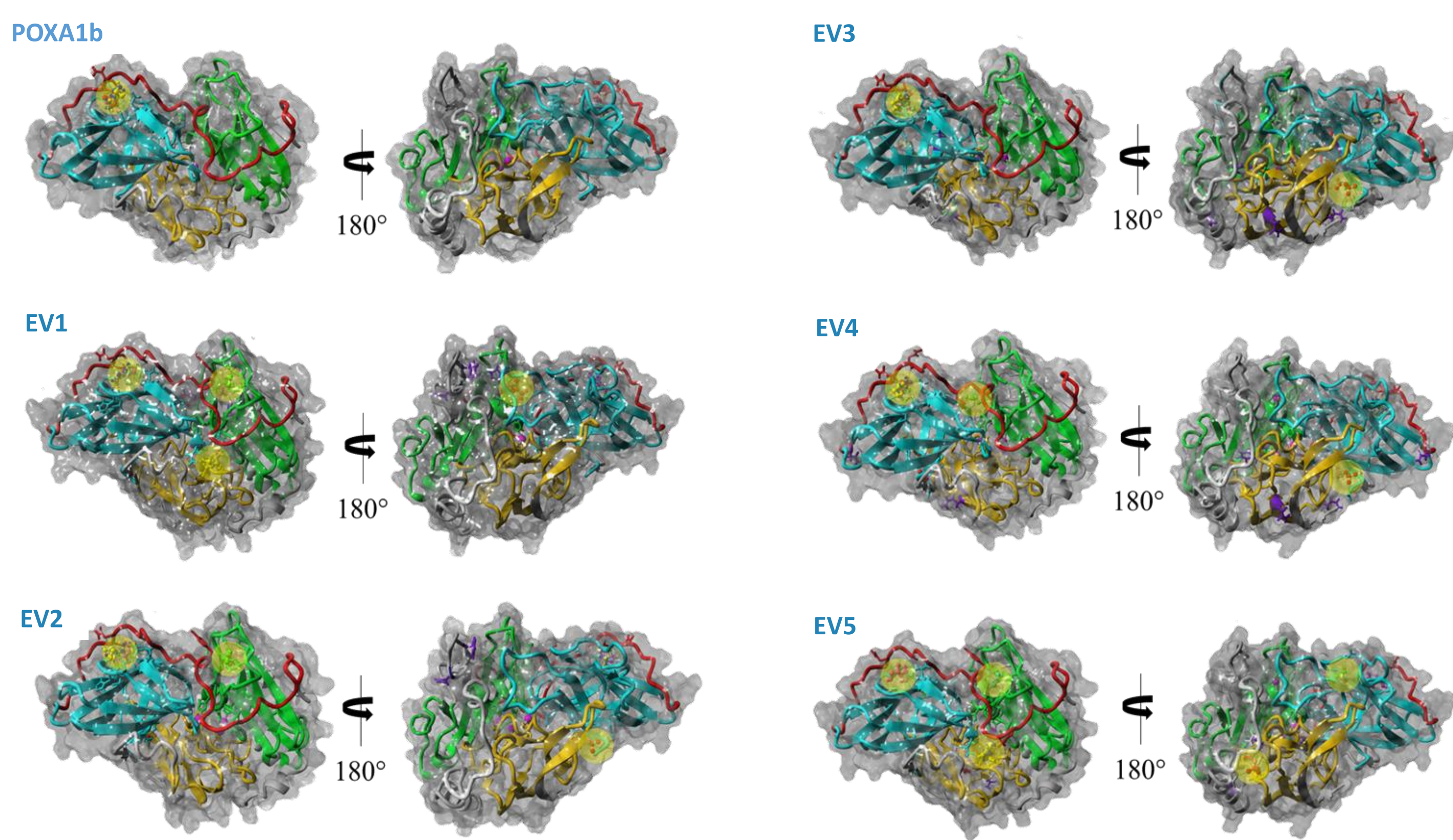
### NADES

**Hydrogen Bond Acceptor**: Betaine  
**Hydrogen Bond Donor**: Sorbitol, Xylitol, Glycerol, Ethylene glycol, Erythritol  
 Solvents with **melting temperature** lower than that of its individual HBD and HBA components; characterized by low flammability, low volatility, facile preparation, high solvability, and compatibility with enzymes

### THERMAL STABILITY OF LACCASES IN NADESs AT 70°C



### SMALL MOLECULE DOCKING BETWEEN LACCASES AND NADES COMPONENTS



- Clear advantage in laccase **thermal stability** in presence of betaine-based NADES.
- Correlation between the **binding energies** of NADES components with laccases and thermal stabilization of the enzymes.
- Different stabilizing effect for every enzyme determined by **precise combination** of **interactions** and **molecule orientation**, suggesting the possibility to tailor the NADES composition for every enzyme of interest.

**NADES media provide a cost-friendly solution to inhibit thermal inactivation of enzymes and could unlock a range of innovative industrial applications such as processing of smart-materials containing enzymes**

### Acknowledgements:

This research was supported by TERMINUS project "in-built Triggered Enzymes to Recycle Multi-layers: an INnovation for Uses in plastic packaging".  
 TERMINUS has received funding from the European Union's Horizon 2020 research and innovation programme, under grant agreement number 814400.

### References:

- [1] Toledo, M. L.; Pereira, M. M.; Freire, M. G.; Silva, J. P. A.; Coutinho, J. A. P.; Tavares, A. P. M. (2019) ACS Sustain. Chem. Eng., 7 (13), 11806– 11814, DOI: 10.1021/acssuschemeng.9b02179;  
 [2] Delorme, A. E.; Andanson, J. M.; Verney, V. (2020) Int. J. Biol. Macromol., 163, 919– 926, DOI: 10.1016/j.ijbiomac.2020.07.022;  
 [3] Varriale, S., Delorme, A. E., Andanson, J. M., Devemy, J., Malfreyt, P., Verney, V., & Pezzella, C. (2021). ACS sustainable chemistry & engineering, 10(1), 572-581. DOI: 10.1021/acssuschemeng.1c07104