From the study of copper containing enzymes to the development of bioinspired catalysts

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Lignocellulosic biomass (composed mainly of polysaccharides and lignin) is increasingly considered as a renewable feedstock to produce bio-sourced chemicals, biomaterials and advanced biofuels. One important step in the valorisation of biomass components into valuable products consists in size reduction of the recalcitrant polymeric components. Lytic Polysaccharide Monooxygenases (LPMOs) are copper-containing enzymes secreted by some bacteria and fungi, among a consortium of enzymes that act collectively to degrade recalcitrant polysaccharides such as cellulose or chitin.[1] LPMO enzymes were shown to oxidatively cleave polysaccharide chains of the polymeric recalcitrant substrates, in contrast to the reactions carried out by relatively well-known hydrolase enzymes. LPMO catalyzes the hydroxylation of a strong C-H bond at the glycosidic linkage of polysaccharides, using either dioxygen (and electrons) or hydrogen peroxide as oxidant, further leading to glycosidic bond cleavage (**Fig 1**).[2] LPMO active center is constituted of a mononuclear copper ion ligated by two histidines including the *N*-terminal histidine ligated in an unusual bidentate binding mode, a motif that has been named "histidine-brace motif".

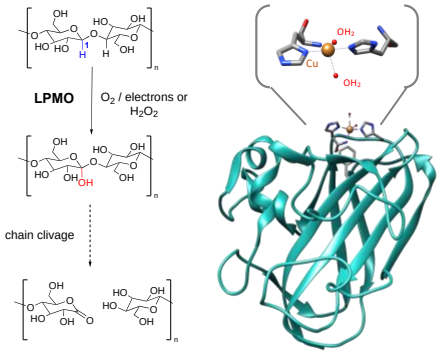

Fig. 1. C1 oxidation of cellulose catalysed by LPMO. Structure of a LPMO (PDB ID 6T5Z) with surface exposed copper active-site.[3a]

Our group combines studies on enzymatic systems[3] (including LPMO) to the development of bioinspired complexes.[4] In particular, we have produced and characterized bacterial LPMOs and evaluated the effect of mutations of active site residues on the properties of the enzymes.[3a,b,d] We have also prepared and characterized copper bioinspired complexes to get insight into mechanistic pathways allowing strong C-H bonds activation at copper centers.[4] Following this interdisciplinary approach, several bioinspired catalysts were prepared and proof-of-concept that some complexes can oxidatively promote polysaccharide depolymerization was obtained.[4c]

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[2] B. Wang, *et al.*, *ACS Catal* **2020**, 10 (21), 12760
[3] a) A. Munzone, *et al.*, *FEBS J*. **2020**, 287 (15), 3298 b) R.J. Gómez-Piñeiro, *et al.*, *Inorg. Chem*. **2022**, 61(20), 8022 c) B. Bissaro, *et al, Science Adv*, **2022**, 8 (51) eade998 d) A. Munzone, M. Pujol *et al.*, *submitted*
[4] a) A.L. Concia, *et al.*, *Inorg. Chem*. **2017**, 56 (3), 1023 b) S. Gamboa-Ramirez, et al., *Chem Eur J*, **2022**, 28 (66), e202202206 c) R. Leblay, *et al., ChemCatChem*, **2023**, 15, e202300933