

1 *Supplementary materials*

2 **Applications of microbial laccases: Patent review of the past decade (2009-2019)**

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Table S1. The patents cited in the main text.

Appearance in text	Title	Patent number	Year of publication	Inventor (Applicant)	Category
1	Freezing point depressed solid matrix compositions for melt granulation of enzymes	WO 2019089898 A1	2019	Nathaniel T. Becker, Joseph C. Mcauliffe, Peyman Moslemy, Jared Enwei Tan, Luther White (Danisco Us Inc) Wayne Ashton,	Enzyme Production, Immobilization and Biocatalysis
2	Laccases and methods of use thereof at low temperature	US 20110302722 A1	2011	Andreas J. Krouwer, Joseph C. McAuliffe, Piera M. Pericu, Huaming Wang (Danisco Us Inc)	Enzyme Production, Immobilization and Biocatalysis
3	Laccase variants having increased expression and/or activity	US 20140123404 A1	2014	Huaming Wang, Michael Ward (Danisco Us Inc)	Enzyme Production, Immobilization and Biocatalysis
4	Specific 7-amino-1,2,3,4-tetrahydroquinolines, method, and composition	WO 2019072697 A1	2019	Aziz Fadli, Zhibo Liu, Céline Richardson (L'oreal)	Pharma / Cosmetics / Agrochemicals
5	Compositions and methods for improving color deposit and durability of color in artificially colored hair	WO2019046396A1	2019	Andrea Elsen, Nghì Van Nguyen, Jim Singer	Pharma / Cosmetics / Agrochemicals
6	Pretreatment process of jute or red ramie	CN102086533A	2013	Liu Guozhong (Jiangsu Bauhinia Textile Technology Co., Ltd.)	Textiles and fibers
7	Refining processing method of fibrilia	CN102517648A	2012	Liu Guozhong Yao Jiangang, Zhang Zhenyao, Zhang Ximing (Jiangsu Bauhinia Textile Technology Co., Ltd.)	Textiles and fibers

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8	A kind of laccase chemical modification method and its application	CN108823177A	2018	Chen Yangmei, Jiang Yu, Wu Qitang, Chen Jiajin, Qiu Zhuotao, Chen Shuanna, (South China Agricultural University) Wang Zhiwei, Wu Ming, Ma Haijun, Huang Huanhuan, Wang Shuangfei, Liu Xinliang, Lu Peng (Guangxi University) Sun Wei, Chen Guang, Yan Zechang, Su Yujie, Wang Gang, Chen Huan, Yu Yu (Jilin Agricultural University)	Lignin removal and modification
9	A method of true qualities mechanical pulp is prepared using laccase treatment bagasse	CN109098025A	2018	Chen Yangmei, Jiang Yu, Wu Qitang, Chen Jiajin, Qiu Zhuotao, Chen Shuanna, (South China Agricultural University) Wang Zhiwei, Wu Ming, Ma Haijun, Huang Huanhuan, Wang Shuangfei, Liu Xinliang, Lu Peng (Guangxi University) Sun Wei, Chen Guang, Yan Zechang, Su Yujie, Wang Gang, Chen Huan, Yu Yu (Jilin Agricultural University)	Lignin removal and modification
10	A kind of myrothecium verrucaria of high yield laccase and application	CN109868224A	2019	Chen Yangmei, Jiang Yu, Wu Qitang, Chen Jiajin, Qiu Zhuotao, Chen Shuanna, (South China Agricultural University) Wang Zhiwei, Wu Ming, Ma Haijun, Huang Huanhuan, Wang Shuangfei, Liu Xinliang, Lu Peng (Guangxi University) Sun Wei, Chen Guang, Yan Zechang, Su Yujie, Wang Gang, Chen Huan, Yu Yu (Jilin Agricultural University)	Enzyme Production, Immobilization and Biocatalysis
11	The CotA laccase and its application that a kind of catalytic efficiency improves	CN109439635A	2019	Guan Zhengbing, Xu Kaizhong, Liao Xiangru (Jiangnan University) Zhang Jie, Zhang Jiaying, Xu Hui,	Enzyme Production, Immobilization and Biocatalysis
12	A method of enzyme is recycled in catalysis reaction	CN109652386A	2019	Zhang Jie, Zhang Jiaying, Xu Hui,	Enzyme Production, Immobilization and Biocatalysis

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13	Enzyme-metal hybrid nanoflowers and its application in repeated batch decolorization of dyes	KR 20190033780A	2019	Sanjay K.S. Patel, Seong Hun Yeong, Jinglin Li, Jung Kul Lee (Univ Konkuk Ind Coop Corp)	Enzyme Production, Immobilization and Biocatalysis
14	Preparation method of poly(methyl methacrylate) coated carboxyl carbon nanotube immobilized laccase	CN107988196A	2018	Zhang Mei, Zhang Yimei, Lai Wei, Wu Panpan, Wang Liqun (North China Electric Power University)	Enzyme Production, Immobilization and Biocatalysis
15	Enzyme-porous carrier composite and manufacturing method thereof	KR 20180041065A	2018	Jung Bae Kim, Hansol Kim (Korea University Industry- Academic Coop Fondation)	Enzyme Production, Immobilization and Biocatalysis
16	Method for biomimetic synthesis of nano zirconium dioxide immobilized laccase	CN107858344A	2018	Wang Meiyin, Wu Huimin (Fuzhou University)	Enzyme Production, Immobilization and Biocatalysis
17	Method for preparing bacterial cellulose adsorbing enzyme and product thereof	TWI622646B	2018	Sheng-Chi Wu, Sian-Ming Wu, Feng-Min Su, (Fooyin University)	Enzyme Production, Immobilization and Biocatalysis
18	Modified diatomite carried immobilized spore laccase as well as preparation method and application thereof	CN105063008A	2018	Guan Zhengbing, Zhou Wen, Liao Xiangru, Cai Yujie, Chen Kang (Jiangnan University)	Enzyme Production, Immobilization and Biocatalysis

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19	New process for preparing biphenyl compounds	WO2016050988A1	2016	Stéphane Grelier, Henri Cramail, Audrey Llevot, Stéphane Carlotti, Etienne Grau (Université De Bordeaux, Institut Polytechnique De Bordeaux, CNRS)	Enzyme Production, Immobilization and Biocatalysis
20	Method for preparing hyaluronic acid substitute through oxidizing chitosan by laccase-TEMPO system	CN104745662A	2015	Qi Jicheng, Yin Yunbei (Tianjin University of Science and Technology)	Pharma / Cosmetics / Agrochemicals
21	A kind of cotton fabrics and its pre-treating method	CN109722908A	2019	Liu Ying; Liu Guohong; Wang Guan; Chen Jie; Zhou Ying (Wuhan Sunhy Biological Co. Ltd)	Textiles and fibers
22	Low-temperature oxygen bleaching activator for pure cotton fabric	CN108642854A	2018	Sun Yi, Xu Yu, Zhang Wei (Sun Yi)	Textiles and fibers
23	Compositions and methods for biodegrading plastic	WO2014167562A1	2014	Alex Sivan, Amir Aharoni, (B.G Negev Technologies Ltd.)	Bioremediation and Detoxification
24	Mesoporous catalysts of magnetic nanoparticles and free-radical-producing enzymes, and methods of use	WO2012122437A2	2012	Stephane C. Corgie, Patarawan Kahawong, Emmanuel Giannelis, Larry P. Walker (Cornell University)	Bioremediation and Detoxification
25	Detergents with improved detergent power, containing at least one laccase	US20180127687A1	2018	Nina Mußmann, Timothy O'Connell, Daniela Herbst, Inken Prieser, Ralf G. Berger, Diana Linke, Christoph Behrens	Detergents

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26	Detergent containing at least one laccase as a dye-transfer inhibitor	US20170267947A1	2017	(Henkel AG and Co KGaA) Nina Mußmann, Timothy O'Connell, Thomas Weber, Mareile Job, Hendrik Hellmuth, Michael Strotz, Inken Prueser	Detergents
27	Preparation method and application of two-dimensional nano rare earth borate laccase sensor	CN103499625A	2015	(Henkel AG and Co KGaA) Hu Ping, Zhou Xinlin, Wu Qingsheng (Tongji University)	Sensors and biofuel cells
28	A kind of preparation of the electrochemical sensor shown with instant visualization colorimetric	CN110068570A	2019	Yu Jinghua, Sun Jianli, Li Li (Ji Nan University)	Sensors and biofuel cells
29	Method for preparing protein/pectin/chitosan composite film by using thermostable recombinant bacterial laccase, and product thereof, and applications of product	CN109111584A	2019	Zhang Chong, Bu Guojian, Zhang Xiaojian (Nanjing Agricultural University, Taixing Dongsheng Bio Tech Co. Ltd.)	Polymers and biopolymers
30	A kind of preparation method of automobile instrument panel sealing element	CN109096736A	2018	Liu Shiming (Quanjiao Xiangrui Plastic Co., Ltd.)	Polymers and biopolymers

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31	Lacquer for paper base lacquer painting and preparation method thereof	CN 109627825	2019	Meng Meilin, Meng Yucun, Sheng Rong (Anhui Polytechnic University)	Paint and coatings
32	Preparation method of thermal-insulation coating for exterior wall	CN 109735175	2019	Lu Na (Changzhou City Richen Decoration Materials Co., Ltd.)	Paints and coatings

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11 **Table S2.** Comparison of recent laccase-related journal publications and patents across categories.

Scientific publications <sup>a</sup>		Patents last decade <sup>b</sup>	
Category	Number of papers (%)	Category	Number of patents (%)
Bioremediation	29	Lignin removal and modification	20
Biofuel cells/Biosensors	22	Biochemistry and Biocatalysis	15
Textile	20	Pharma/ Cosmetics/ Agrochemicals	13
Pulp and paper	11	Textiles and fibers	11
Food	10	Bioremediation	10
Organic synthesis	4	Food and beverages	8
Biofuels	2	Detergents	8
Fiberboards	0.7	Biofuel cells/ Biosensors	7
Cosmetics	0.7	Plastics and biopolymers	4
Paints	0.3	Paints and Coatings	2
		Miscellaneous	2

12 <sup>a</sup> Mate and Alcalde, [57]. <sup>b</sup> SciFinder database (2008-2019).

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