SUPPORTING INFORMATION

Label-free detection of lectins on carbohydrate-modified boron-doped diamond surfaces

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General Procedures and Materials

All reactions were monitored by TLC on Kieselgel 60 F254 (E. Merck). Detection was achieved by charring with vanillin. Silica gel (E. Merck, 240-400 mesh) was used for chromatography. Optical rotation was measured with a JASCO DIP-370 digital polarimeter, using a sodium lamp (λ = 589 nm) at 20 °C. All NMR experiments were performed at 300.13 MHz using a Bruker DPX300 spectrometer equipped with a Z-gradient unit for pulsed-field gradient spectroscopy. Assignments were performed by stepwise identification using COSY, and HSQC experiments using standard pulse programs from the Bruker library. Chemical shifts are given relative to external TMS with calibration involving the residual solvent signals. Low-resolution ESI mass spectra were obtained on a hybrid quadrupole/time-of-flight (Q-TOF) instrument, equipped with a pneumatically assisted electrospray (Z-spray) ion source (Micromass). High-resolution mass spectra were recorded in positive mode on a ZabSpec TOF (Micromass, UK) tandem hydrid mass spectrometer with EBETOF geometry. The compounds were individually dissolved in MeOH at a concentration of 10 $\mu g.mL^{-1}$ and then infused into the electrospray ion source at a flow rate of 10 $\mu L.min^{-1}$ at 60 °C. The mass

spectrometer was operated at 4 kV whilst scanning the magnet at a typical range of 4000-100 Da. The mass spectra were collected as continuum profile data. Accurate mass measurement was achieved using polyethylene glycol as internal reference with a resolving power set to a minimum of 10 000 (10% valley).

Glutaric anhydride, propargyl alcohol, 3-bromo-1-propanol, (+)-sodium L-ascorbate, lactose, mannose, monohydrate 4-dimethylaminopyridine, pyridine, sodium methoxide, sodium azide, tetra-*n*-butylammonium iodide, dichloromethane (CH_2Cl_2), N, N-dimethylformamide (DMF), cyclohexane, methanol, ethyl acetate (EtOAc), acetic anhydride, hydrochloric acid (HCl), sodium bicarbonate, magnesium sulphate ($MgSO_4$), dicyclohexylcarbodiimide (DCC), copper(II) sulphate pentahydrate ($CuSO_4 \times 5H_2O$) and boron trifluoride etherate ($BF_3.Et_2O$) were obtained from Aldrich and used without further purification.

Synthesis of 5-oxo-5-(prop-2-ynyloxy)pentanoic acid

The 5-oxo-5-(prop-2-ynyloxy)pentanoic acid **(1)** was prepared as described previously.[1] A solution of glutaric anhydride (2 g, 17.52 mmol), propargyl alcohol (1.08 g, 19.27 mmol) and 4-dimethylaminopyridine (catalytic amount) in anhydrous CH_2Cl_2 (60 mL) was stirred under N_2 for 12 h at room temperature. The resulting solution was diluted in CH_2Cl_2 (200 mL) and washed with HCl (20 mL, 0.1 M) and brine. The organic layer was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by column chromatography (SiO_2: petroleum ether:ethyl acetate=3:2) to give a colorless oil (68%): ^{1}H NMR (300 MHz, $CDCl_3$) δ(ppm): 9.90 (br.s, 1H), 4.65 (d, 2H, J = 1.3 Hz), 2.48-2.45 (m, 5H), 1.93 (q, 2H, J = 7.2 Hz).

Per-*O*-acetyl lactose (2): Lactose monohydrate (20 g, 0.06 mol) was dissolved in pyridine (240 mL) at ambient temperature. Acetic anhydride (240 mL, 2.55 mol) was added dropwise to this mixture and allowed to stir for 12 h with the exclusion of moisture. The reaction was cooled to 0 °C and methanol was added dropwise *carefully* (exothermic) and the mixture then left to warm up to ambient temperature. The solvents were then concentrated *in vacuo* and the resulting residue was dissolved in CH_2Cl_2. The organic phase was washed sequentially with saturated sodium bicarbonate solution and water. The organic layers were combined, dried over magnesium sulphate, filtered and concentrated *in vacuo* to yield the β-glycoside **2** as a yellow solid (37 g, 98%): Rf = 0.2 (cylohexane:ethyl acetate = 1:1); ^{1}H NMR (300 MHz, $CDCl_3$) δ(ppm): 6.29-6.28 (d, 1H, J = 3.0 Hz), 5.53-5.49 (t, 1H, J = 9.0 Hz), 5.39-5.38 (d,

1H, *J* = 3.0 Hz), 5.19-5.13 (dd, 1H, *J* = 3.0 Hz, *J* = 3.0 Hz), 5.06-4.97 (m, 2H), 4.53-4.46 (m, 2H), 4.18-4.12 (m, 3H), 3.94-3.82 (m, 2H), 2.21 (s, 3H), 2.20 (s, 3H), 2.19 (s, 3H), 2.15 (s, 3H), 2.10 (s, 3H), 2.09 (s, 3H), 2.04 (s, 3H), 2.00 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ(ppm): 170.3-168.9 (C=O), 101.2 (C1), 88.9 (C1'), 75.8, 71.0, 69.6, 69.4, 69.2, 66.6, 61.5, 60.8, 20.9-20.5.

Per-*O*-acetyl-(3-bromopropyl)-β-D-lactoside (3): To a solution of compound **2** (2.5 g, 3.6 mmol) in dry CH_2Cl_2 (15 mL) was added 3-bromo-1-propanol (500 µL, 5.8 mmol). The resulting mixture was stirred at ambient temperature for 5 min before addition of $BF_3.Et_2O$ (3 mL, 19.9 mmol) and stirred for an additional 12 h at this temperature. The reaction mixture was then washed with a saturated solution of sodium bicarbonate and the organic layer dried over magnesium sulphate, filtered and evaporated. The crude solid thus obtained was purified by silica gel column chromatography (cyclohexane:ethyl acetate = 57:43) to give **3** as a white solid (500 mg, 18%): R*f* = 0.5 (cylohexane:ethyl acetate = 2:3); ^{1}H NMR (300 MHz, $CDCl_3$) δ(ppm): 5.27 (d, 1H, *J* = 2.8 Hz, H-4'), 5.13 (t, 1H, *J* = 9.6 Hz, H-3), 5.03 (dd, 1H, *J* = 10.8 and 8.4 Hz, H-2'), 4.87 (dd, *J* = 10.4 and 3.6 Hz, H-3'), 4.81 (dd, *J* = 10.0 and 7.6 Hz, H-2), 4.44-4.40 (m, 3H, H-1, H-1' and H-6'a), 4.09-3.99 (m, 3H, H-5', H-6'b and H-6a), 3.88 (m, 1H, OCH_2a), 3.82 (t, *J* = 7.2 Hz, H-6b), 3.73 (t, *J* = 9.6 Hz, H-4), 3.62-3.53 (m, 2H, OCH_2b and H-5), 3.40-3.36 (m, 2H, CH_2Br), 2.08, 2.05, 1.99, 1.98, 1.97, 1.89 (s, 21H, 7 × $COCH_3$), 2.04-1.93 (m, 2H, -CH_2-).

Per-*O*-acetyl-(3-azidopropyl)-β-D-lactoside (4): This compound was synthesized as described.[2] A mixture of compound **3** (0.90 g, 1.18 mmol), sodium azide (0.45 g, 6.92 mmol) and a catalytic amount of tetra-*n*-butylammonium iodide (50 mg) in dry DMF (20 mL) was stirred at 60 °C for 2 h. The reaction mixture was then diluted with ethyl acetate, washed successively with water and brine, dried over Na_2SO_4, filtered and concentrated. The crude syrup thus obtained was purified by column chromatography on silica gel (cyclohexane:ethyl acetate = 1:1) to give the azido compound **4** as a white foam (0.85 g, 100%). R*f* = 0.4 (cylohexane:ethyl acetate = 2:3); ^{1}H NMR (300 MHz, $CDCl_3$) δ(ppm): 5.21 (d, 1H, *J* = 3.0 Hz, H-4'), 5.06 (t, 1H, *J* = 9.0 Hz, H-3), 4.96 (dd, 1H, *J* = 10.0 and 8.0 Hz, H-2'), 4.83 (dd, 1H, *J* = 10.0 and 3.0 Hz, H-3'), 4.75 (dd, *J* = 10.0 and 7.0 Hz, H-2), 4.40-4.35 (m, 3H, H-1, H-1' and H-6'a), 4.03-3.93 (m, 3H, H-5', H-6'b and H-6a), 3.80-3.75 (m, 2H, OCH_2a, H-6b),

3.68 (t, *J* = 9.0 Hz, H-4), 3.52-3.44 (m, 2H, OCH_2b and H-5), 3.28-3.19 (m, 2H, CH_2Br), 2.02, 1.99,1.93, 1.92, 1.83 (s, 21H, 7 × $COCH_3$), 1.76-1.64 (m, 2H, -CH_2-).

3-azidopropyl-β-D-lactoside (5): This compound was synthesized as described previously.[2] To compound **4** (0.5 g, 0.6 mmol) dissolved in dry methanol (10 mL) was added a freshly made sodium methoxide solution (2 mL, 1 mol/l). The resulting mixture was stirred at ambient temperature for 4 h. The reaction was then neutralized with Amberlite IR-120 (H^+) resin, filtered and concentrated to give the deacetylated target azido compound **5** as a white solid (280 mg, 95%). This compound was used in the next step without further purification: R*f* = 0.0 (cylcohexane: ethyl acetate = 2:3); ^{1}H NMR (300 MHz, D_2O) δ(ppm): 4.29 (d, 1H, *J* = 8.0 Hz, H-1), 4.25 (d, 1H, *J* = 7.0 Hz, H-1'), 3.81-3.77 (m, 2H), 3.73 (d, 1H, *J* = 3.0 Hz), 3.63-3.33 (m, 12H), 3.29 (t, 2H, *J* = 6.0 Hz), 3.12 (m, 1H), 1.72 (m, 1H). ^{13}C NMR (75MHz, D_2O) δ(ppm): 103.45, 102.25, 78.49, 75.47, 74.89, 74.49, 72.92, 72.64, 71.07, 68.67, 67.47, 61.16, 60.20, 47.99, 28.37.

Azidopropanol (6):[3] To a solution of 3-bromo-propan-1-ol (1.92 g, 13.8 mmol) in water (40 mL) was added sodium azide (1.80 g, 20 mmol) and the solution was heated at 80 °C for 18 h. The aqueous solution was extracted with EtOAc and the organic layers were combined, washed with brine (30 mL), dried over $MgSO_4$, filtered and concentrated *in vacuo* to give pure 3-azido-propanol as a colorless oil (1.09 g, yield = 78%): ^{1}H NMR (300MHz, D_2O) δ(ppm): 3.76 (t, 2H, *J* = 6.0 Hz, H-3), 3.45 (t, 2H, *J* = 6.6 Hz, H-1), 1.84 (qt, 2H, *J* = 6.6 Hz, H-2),

3-azidopropyl-β-D-mannose (7): D-mannose (2.00 g, 11 mmol) was added to **6** (6 g, 60 mmol) and H_2SO_4-SiO_2 (600 mg). The reaction mixture was heated at 80 °C for 24 h. The crude mixture was purified on silica gel (CH_2Cl_2:MeOH= 8:2) to give compound **7** (1.1 g, 37%). R*f* = 0.0 (cylcohexane: ethyl acetate = 2:3). ^{1}H NMR (300 MHz, D_2O) δ(ppm): 4.81-4.80 (d, 1H, *J* = 1.8 Hz, H-1); 3.90-3.89 (m, 1H, H-2); 3.87-3.81 (dd, 1H, *J* = 12.1 Hz, *J* = 1.5Hz, H-6a); 3.77-3.71 (m, 3H, H-6b, H-1', H-3); 3.59-3.52 (m, 3H H-1', H-4, H-5); 3.41-3.37 (t, 2H *J* = 7.0 Hz, H-3'); 1.89-1.80 (q, 2H, *J* = 1.1 Hz, H-2'). ^{13}C NMR (75 MHz, D_2O) δ(ppm): 99.8, 72.8, 70.6, 70.0, 66.7, 64.8, 60.9, 48.2, 27.9.

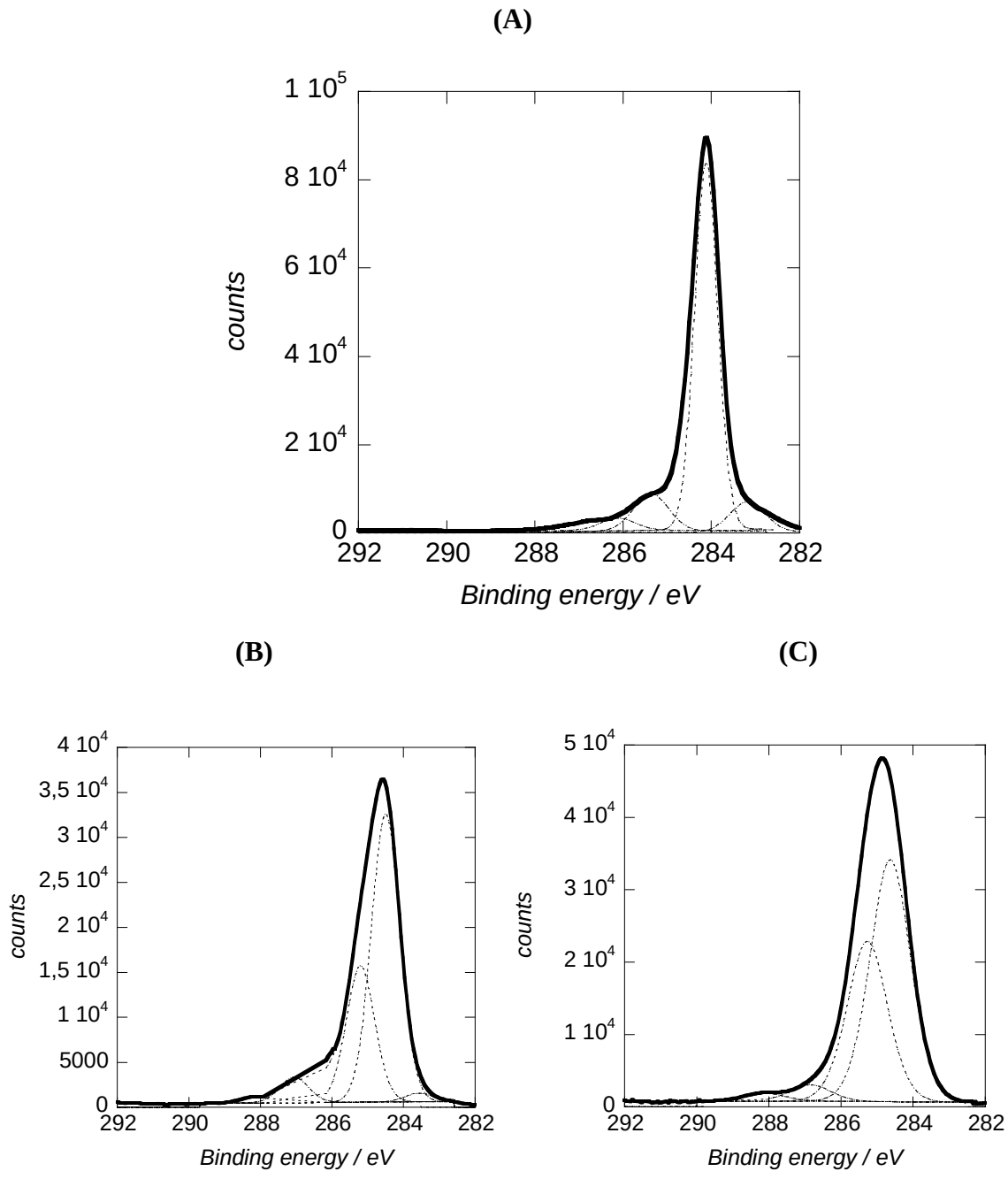

Figure S1. High-resolution XPS spectra of the C1s band (A) oxidized, (B) alkynyl- and (C) lactose-functionalized BDD surfaces.

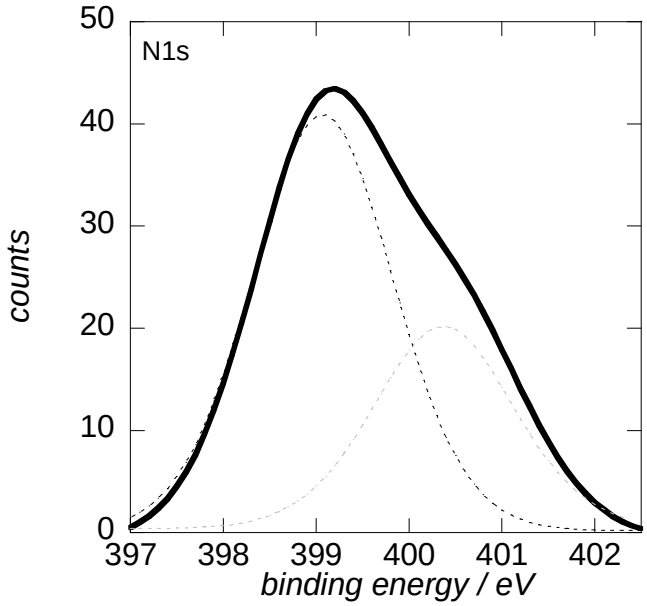

Figure S2. High-resolution XPS spectrum of the N1s band of a lactose-functionalized BDD surface.

References

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