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Comprehensive single molecule dynamics and functions of lysozyme upon linear and cross-linked substrate using a carbon nanotube circuit YONGKI CHOI, PATRICK C. SIMS, BRAD L. CORSO, Department of Physics and Astronomy, University of California, Irvine, ISSA S. MOODY, Department of Molecular Biology, University of California, Irvine, DAVID SEITZ, LARRY BLASZCAZK, Muroplex Therapeutics, Inc., GREGORY A. WEISS, Department of Molecular Biology, University of California, Irvine, PHILIP G. COLLINS, Department of Physics and Astronomy, University of California, Irvine — The dynamic processivity of individual lysozyme molecules was monitored in the presence of either linear or cross-linked peptidoglycan substrates using a single-walled carbon nanotube transistor. The substrate-driven, hinge bending motions of lysozyme induce dynamic electronic signals in the underlying transistor to allow long-term monitoring of the same molecule, all without the limitations of fluorophore quenching or bleaching. For both types of substrates, lysozyme exhibits slow, processive turnover at 20 Hz and also rapid, nonproductive motions at 300 Hz. However, the latter type of motion nearly vanishes with the linear substrate, which lacks cross-links. Specifically, the nonproductive binding fills 43% of the enzyme's total activity when the substrate has cross-links, but only 7% with the cross-links are absent. The continuous, uninterrupted processing indicates that lysozyme can catalytically hydrolyze glycosidic bonds all the way to the end of a linear substrate, and that the motion attributed to nonproductive binding may be the lysozyme sidestepping the peptide cross-links.

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