Is cellulose synthesis a Brownian ratchet?

Despite its importance for the plant and for humanity, cellulose is made by a mechanism that remains enigmatic. In the test tube, cellulose is synthesized with difficulty or not at all, limiting the standard tools of biochemistry. We do know that cellulose is made by an enzyme complex at the plasma membrane. The complex takes (activated) glucose from the cytosol and polymerizes it into unbranched chains, where the glucose moieties are linked in a way that allows the chain to adopt a linear conformation. The complex makes (probably) 18 chains, which after extrusion from the enzyme complex crystalize into a microfibril. As the microfibril gets extended, the complex moves in the plasma membrane. We do understand neither how the 18 chains coalesce into a crystalline microfibril nor how crystallization in effect pushes the enzyme complex. To illuminate this process, we imaged the motion of the synthase tagged with a fluorescent protein at high resolution. Based on analyzing the trajectories and fitting them to models for assisted diffusion, I will attempt to answer the question posed in the title.

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