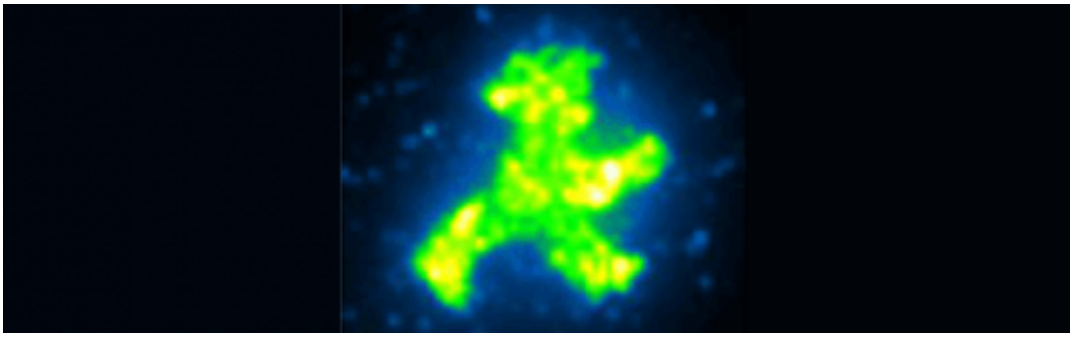
Nanosciences: All systems go at the biofactory

September 28 2012



In order to assemble novel biomolecular machines, individual protein molecules must be installed at their site of operation with nanometer precision. Ludwig Maximilian University researchers have now found a way to do just that. Green light on protein assembly.

The finely honed tip of the atomic force microscope (AFM) allows one to pick up single biomolecules and deposit them elsewhere with nanometer accuracy. The technique is referred to as Single-Molecule Cut & Paste (SMC&P), and was developed by the research group led by LMU physicist Professor Hermann Gaub. In its initial form, it was only applicable to DNA molecules. However, the molecular machines responsible for many of the biochemical processes in cells consist of proteins, and the controlled assembly of such devices is one of the major

goals of nanotechnology. A practical method for doing so would not only provide novel insights into the workings of living cells, but would also furnish a way to develop, construct and utilize designer nanomachines.

In a major step towards this goal, the LMU team has modified the method to allow them to take proteins from a storage site and place them at defined locations within a construction area with nanometer precision. "In liquid medium at room temperature, the "weather conditions" at the nanoscale are comparable to those in a hurricane," says Mathias Strackharn, first author of the new study. Hence, the molecules being manipulated must be firmly attached to the tip of the AFM and held securely in place in the construction area.

Traffic signals prove the efficiency

The forces that tether the proteins during transport and assembly must also be weak enough not to cause damage, and must be tightly controlled. To achieve these two goals, the researchers used a combination of antibodies, DNA-binding "zinc-finger" proteins, and DNA anchors. "We demonstrated the method's feasibility by bringing hundreds of fluorescent GFP molecules together to form a little green man, like the traffic-light figure that signals to pedestrians to cross the road, but only some micrometers high," Strackharn explains.

With this technique, functional aspects of complex protein machines - such as how combinations of different enzymes interact, and how close together they must be to perform coupled reactions - can be tested directly. A further goal is to develop artificial multimolecular assemblies modeled on natural "cellulosomes", which could be used to convert plant biomass into biofuels. Strackharn points out the implications: "If we can efficiently build mimics of these 'enzymatic assembly lines' by bringing individual proteins together, we could perhaps make a significant contribution to the exploitation of sustainable energy sources."

More information: Nanoscale Arrangement of Proteins by Single-Molecule Cut-and-Paste, Mathias Strackharn, Diana A. Pippig, Philipp Meyer, Stefan W. Stahl, and Hermann E. Gaub, *J. Am. Chem. Soc.*, 2012, 134 (37), pp 15193. doi: 10.1021/ja305689r