An organic active adaptation transistor with light intensity-dependent photoadaptation

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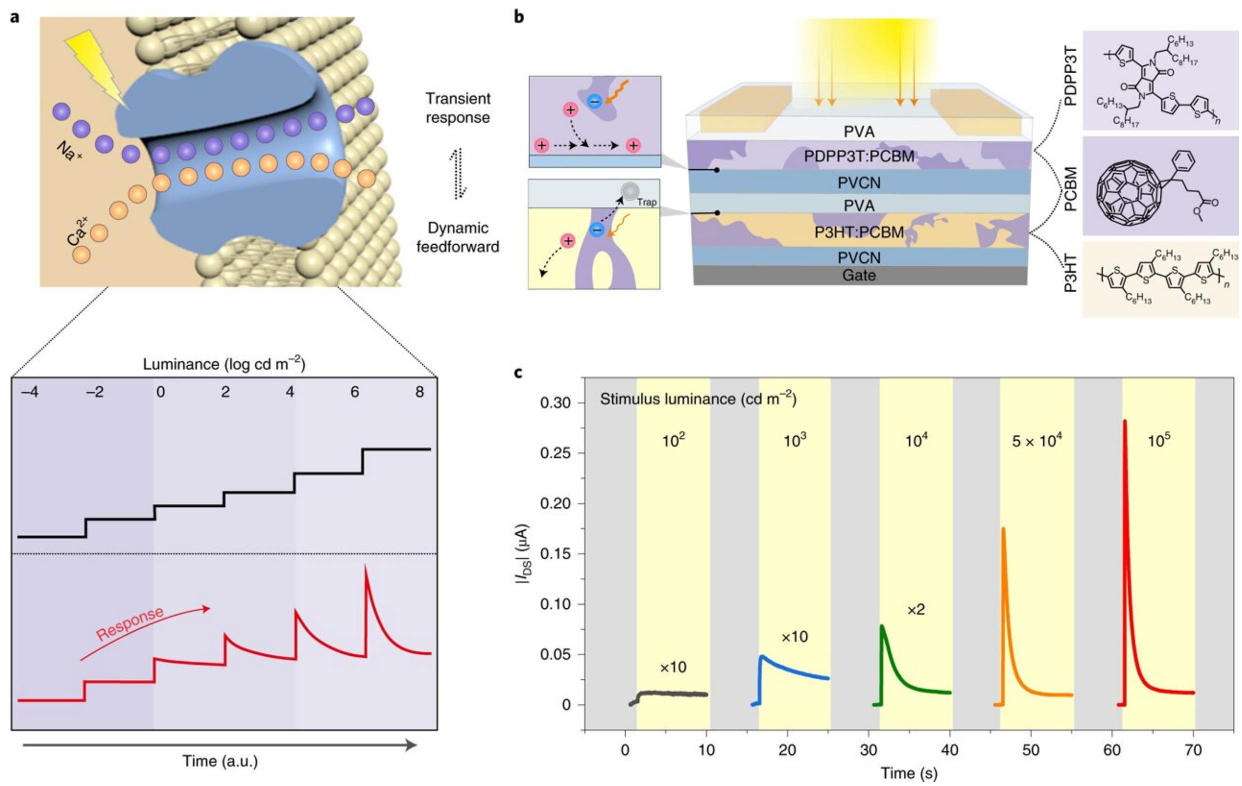

a, Top: schematic of the photoresponse in the photoreceptor of a human being and the response characteristics. Bottom: the individual response in one luminance step. When the luminance is periodically increased in steps, the response follows a sawtooth curve. With each increase in luminance, the response jumps and then settles back to the equilibrium level that results when the eye has adapted to the luminance stimulus. b, Schematic of an OAAT with two complementary BHJs. c, Real-time photoresponse of an OAAT to various stimuli luminances on a dark background. The applied V_{DS} and V_{GS} were −1 and −4 V, respectively. Credit: *Nature Electronics* (2021). DOI:

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A team of researchers from the Beijing National Laboratory for Molecular Sciences, the Chinese Academy of Sciences and the University of Chinese Academy of Sciences, has developed an organic active adaptation transistor (OAAT). In their paper published in the journal *Nature Electronics*, the group describes how they overcame a hurdle involving charge transport, and explores possible uses for their OAAT.

The human eye is able to conduct a type of on-the-fly adaptation—when moving from a dark theater, for example, the eye automatically undergoes changes to respond to a bright day outside—and it is not as simple as just changing the amount of light let through the lens by opening or constricting the pupil. Changes must also take place in the back of the eye where different types of ions are transported. In this new effort, the researchers sought to replicate this process by creating a photo adaptive device—one that might one day be used to restore vision in those with eye damage.

Shortly after embarking on their work, the researchers came upon a major hurdle—how to handle the conflicting demands of the charge transport—where both inhibition and photoexcitation are needed. After much experimentation, they came up with a novel idea—introducing two bulk heterojunctions as two different layers of their device. One would serve as a photo-responsive active layer, the other as a floating gate.

After more experimentation, the group came up with a fully functioning seven-layer device: The first layer was a polyvinyl alcohol (PVA), a dielectric. Underneath that sat the first heterojunction. Next came a poly(vinyl-cinnamate) (PCVN), another dielectric. Then, another layer of PVA, followed by the second heterojunction, then another PCVN layer, and finally a gate.

Once their device was complete the researchers discovered that they had no good way to test it. After three months of discussion, they came up with what they call the 'active adaptation index'—it could be used to test adaptation in the human eye and then to compare that with their newly developed OAAT. They found the scores from the two sources to be remarkably similar.

The researchers suggest their work represents a first step toward creating adaptive devices for use both in robotics and in devices meant to replace organs in human patients.

More information: Zihan He et al, An organic transistor with light intensity-dependent active photoadaptation, *Nature Electronics* (2021). DOI: 10.1038/s41928-021-00615-8