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An organic nanoparticles transistor behaving as a spiking synapse DOMINIQUE VUILLAUME, FABIEN ALIBART, IEMN-CNRS, CHRISTOPHE NOVEMBRE, CEA-LIST, DAVID GUERIN, CNRS-IEMN, STEPHANE PLEUTIN, KAMAL LMIMOUNI, IEMN-CNRS, CHRISTIAN GAMRAT, CEA-LIST, IEMN-CNRS TEAM, CEA-LIST TEAM — We demonstrate that an organic transistor, made of metal nanoparticles (NP) embedded into an organic semiconductor channel, behaves as a spiking synapse. We demonstrate that this device exhibits the main behavior of a biological synapse. For instance, it can be programmed to work as an excitatory or inhibitory synapse; it exhibits shot-term plasticity as well as spike timing dependent plasticity. This behavior is obtained by virtue of the combination of two properties: the transconductance gain of the transistor and the memory effect due to charges stored in the NP. The gold NP are immobilized into the source-drain channel by using surface chemistry (self-assembled monolayers) and they were subsequently covered by a thin film of pentacene. In a biological synapse, the excitatory behavior means that an incoming signal with a given frequency and duty cycle induces a post-synaptic signal having an increasing trend, whereas in the case of an inhibitory synapse, the post-synaptic signal tends to decrease. This behavior is exactly what we demonstrated for the ONTS.

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