Hybrid Field Effect Transistor (HFET): A fully covalent transistor with a pi-conjugated organosilica

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Here we demonstrate the use of novel organosilica materials embedding π-conjugated moieties as semiconductor into field effect transistors. The π-conjugated core chosen is [1]benzothieno[3,2-b][1]benzothiophene (BTBT),[1] first functionalized with hydroxyl groups[2] and then modified with hydrolysable and cross-linkable triethoxysilyl moieties. After polycondensation, this compound forms a hybrid material composed of charge transport pathways as well as insulating layers (SiOx). However, overall, the material is found to be a semiconductor and can be incorporated into field effect transistors. Taking advantage of the solgel chemistry[3] involved here, we built Hybrid Field Effect Transistors that are fully cross-linked with covalent bonds.[4] Molecules are cross-linked to each other, covalently bonded to the silicon oxide dielectric and also covalently bonded to the gold electrode thanks to the use of an appropriate additional interfacial monolayer in between. This is the first report of fully covalent transistors. Those devices show impressive resilience against polar, aliphatic and aromatics solvents (even under sonication). This study opens the route towards a new class of hybrid materials to create highly robust electronic applications.[5]

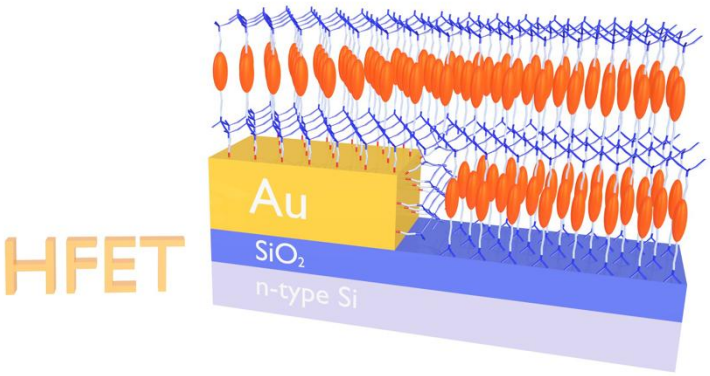

Figure 1: Hybrid Field Effect Transistors (HFET), First example of a field effect transistor based on an entirely reticulated organosilica active layer.

References

1- T. Izawa, E. Miyazaki, and K. Takimiya, *Adv. Mater.,* **2008**, *20*, 3388.

2- G. H. Roche, Y.-T. Tsai, S. Clevers, D. Thuau, F. Castet, Y. H. Geerts, J. J. E. Moreau, G. Wantz and O. J. Dautel, *J. Mat. Chem. C*, **2016**, 6742.

3- O. J. Dautel, G. Wantz, R. Almairac, D. Flot, L. Hirsch, J.-P. Lere-Porte, J.-P. Parneix, F. Serein-Spirau, L. Vignau, and J. J. E. Moreau, *J. Am. Chem. Soc*., **2006**, *128*, 4892.

4- Gilles H. Roche, Damien Thuau, Pierre Valvin, Simon Clevers, Thomas Tjoutis, Sylvain Chambon, David Flot, Yves H. Geerts, Joël J. E. Moreau, Guillaume Wantz and Olivier J. Dautel, *Adv. Electron. Mater.* **2017**, 1700218.

5- Roche, Chueh, Moreau, Takimiya, Wantz, Dautel - **Under Preparation**