Devices

Paul Scherrer Inst.: Contact doping in metal-organic semiconductor devices

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F_4TCNQ doping and its consequences

In this article, the authors from the **Paul Scherrer Institute** present the impact of local doping at metal contact – organic semiconductor interfaces. They show a significant improvement in the injection efficiency, explained by a reduction of the barrier at the interface (Figure 1).

This information is not completely new but the experiment is well conducted and the results are clearly presented. An extended analysis such as the extraction of DOS (Density of State) as a function of energy has indeed been conducted.

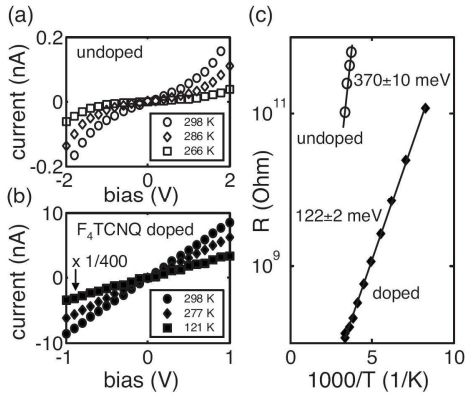

Figure 1: Resistance reduction with doping. *Reprinted with permission from Applied Physics Letters 94, 253306 (2009). Copyright 2009 American Institute of Physics.*

C. Vanoni et al. shows that the impact of F_4TCNQ is to reduce the barrier between the metal contact and the organic semiconductors, by increasing the density of state (like a dopant level – Figure 2) at 138 meV from the HOMO center level. This mechanism explaining the reduction of barrier height to injection is justified by two independent measurements, namely activation energy of contact resistance and DOS extraction from field-effect transistors conductance give similar results in term of dopant level energy (between 138 and 158 meV).

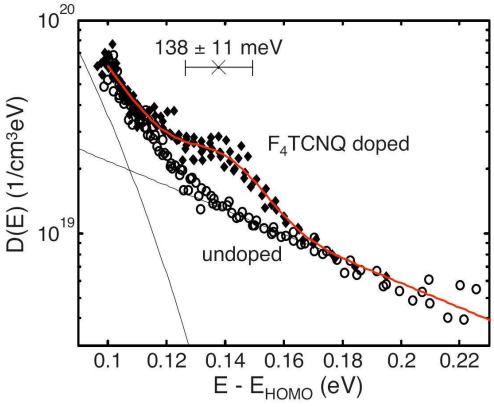

Figure 2: Doping level energy extraction. *Reprinted with permission from Applied Physics Letters 94, 253306 (2009). Copyright 2009 American Institute of Physics.*

This work suggests that even if doping for organic semiconductor has not been very successful for field effect transistors, the approach has to be evaluated and optimized, with the goal of reducing contact resistance. This method and associated mechanism, i.e. the increase of density of state by doping to reduce barrier height, has to be compared to favourite approaches currently used such as metal interface modification by polar SAMs, well known for improving injection efficiency. Indeed,

local doping of semiconductor is the standard method use to reduce barrier height for injection of carrier in the majority of inorganic semiconductor. It has been successfully applied for a wide range of devices (diode, bipolar and field-effect transistors). Moreover, engineering of dopants distribution and activation is probably one of the key of the success of silicon, as it allows to precisely tailor the trade-off between performances, reliability, electrical integrity and many others parameters. This work is promising since self-aligned doping and stabilization of doping materials in organic semiconductor will become challenging, mainly due to the high diffusion coefficient of dopants.

"Temperature dependent charge-injection at the metal-organic semiconductor interface and density of states in pristine and doped pentacene" ; C. Vanoni, T.A. Jung & S. Tsujino : Applied Physics Letters **94**, 253306 (2009).