Assembly of 2D ionic layers by reaction of alkali halides with an organic electrophile – TCNQ

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The remarkable electron-affinity of TCNQ (7,7,8,8-tetracyano-p-quinodimethane) allows charge-transfer (CT) not only with metals [1-4] and organic electron-donors [5], but also by oxidation of halogens in alkali-halides [6,7].

In the present study NaCl and LiCl have been selected as two alkali-halides to undergo a surface confined CT reaction. Sublimation of NaCl and LiCl onto a pre-assembled hydrogen-bonded layer of TCNQ on Au(111) [8] resulted in the formation of 2D ionic layers via a CT reaction without involvement of the substrate.

To demonstrate that CT occurs between the reactants, and not with the Au(111) substrate, spectro-microscopy correlation experiments were performed. They involved scanning tunneling microscopy (STM) (Fig. 1) and photoelectron spectroscopy in the X-ray and UV range (Fig. 2). In case of TCNQ/Au(111) we find that no CT is occurring with the substrate (c.f. [8]) while on Ag(111) TCNQ is found to undergo substrate-to-molecule CT.

Our experiments [11] suggest that by choosing various combinations of other salts and electron acceptors similar to TCNQ, ultra-thin ionic layers with tunable electronic and magnetic properties can be prepared without having to rely on i.e. alkali metals, where excess atoms can easily undergo CT with the substrate.

References

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Figures

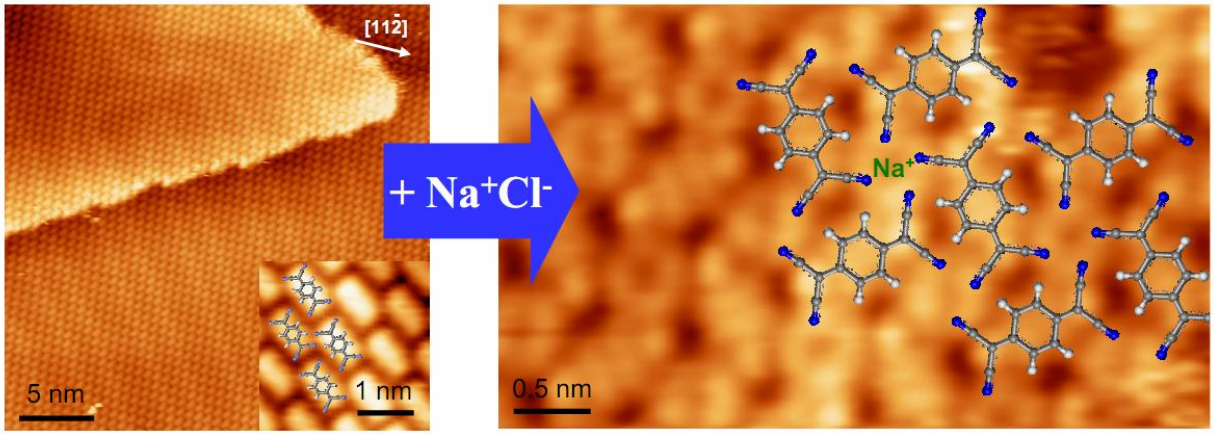

Fig. 1: STM image of the TCNQ layer on Au(111) before and after addition of NaCl.

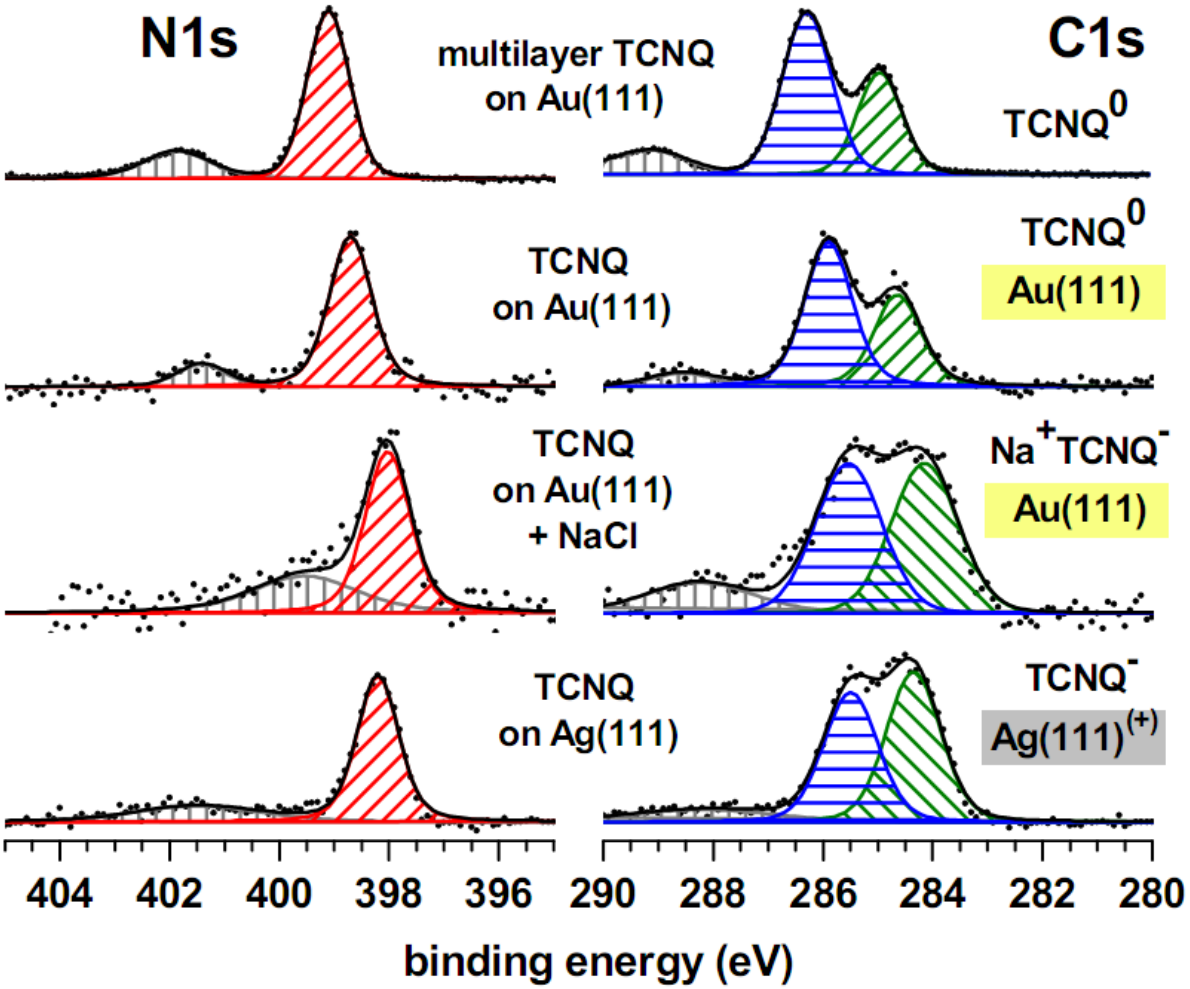

Fig. 2: N1s and C1s XP spectra show evidence for neutral (TCNQ/Au(111)) and negatively charged TCNQ, accompanied by aromatization (TCNQ + NaCl/Au(111)) and TCNQ/Ag(111)) derived from the characteristic C1s peak shapes [9,10].