Bonding of thymidine monophosphate on polycrystalline cerium oxide thin films studied by surface sensitive techniques

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Cerium oxide is a suitable material for DNA-functionalized biosensors for a broad range of analytes like complementary DNAs, proteins or smaller molecules with its outstanding optical and electrical properties [1-5]. In this study we explored the electronic structure and adsorption geometry of the nucleotide thymidine monophosphate (TMP) adsorbed on compact polycrystalline cerium oxide surfaces by means of synchrotron radiation photoelectron spectroscopy (SRPES) and X-ray absorption spectroscopy (XAS). TMP was successfully deposited from aqueous solution ex situ in an inert atmosphere of the glove bag. This was the first time that a model study of TMP on cerium oxide was carried out. C 1s core level spectra (see Fig. 1) clarified that the biomolecule remained intact on the surface after deposition. N 1s core level spectra (see Fig. 1) look similar to already published N 1s spectra of TMP on Al_2O_3, studied together with density functional theory calculations, for which an adsorption mode via phosphate group and carbonyl groups were concluded [6]. Although the bonding via deprotonated nitrogen atom of thymine cannot be excluded, according to our previous results for the thymine/CeO_2 system. Thermal stability was probed by means of SRPES and sample annealing up to 250 °C, whereby TMP tends to decompose at around 150 °C. Resonant photoelectron spectroscopy has also shown that TMP adsorption on CeO_2 was accompanied by surface reduction during thermal treatment.

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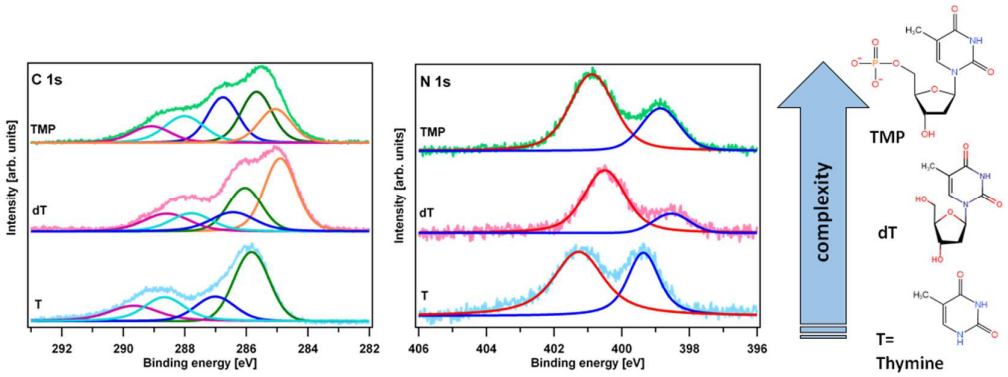

Fig. 1. C 1s (hv= 410 eV) and N 1s (hv= 475 eV) spectra recorded at 25 °C for thymine (T), thymidine (dT) and thymidine monophosphate (TMP) deposited from aqueous solution on compact CeO_2 films obtained by SRPES.