4 Ca and Mg as counter electrode materials

Although the current work is concentrated on the interface TCO-organics, an additional experiment was made in order to observe the effect of change in the work function of the metal back-electrode. Changing the material of the metal electrode with one possessing different work function should change V_{oc} of the cell [**68**]. We produced standard cells with untreated ITO where instead of Al as metal electrode Ca and Mg were used. The resulting I/V characteristics are plotted on Figure 62.

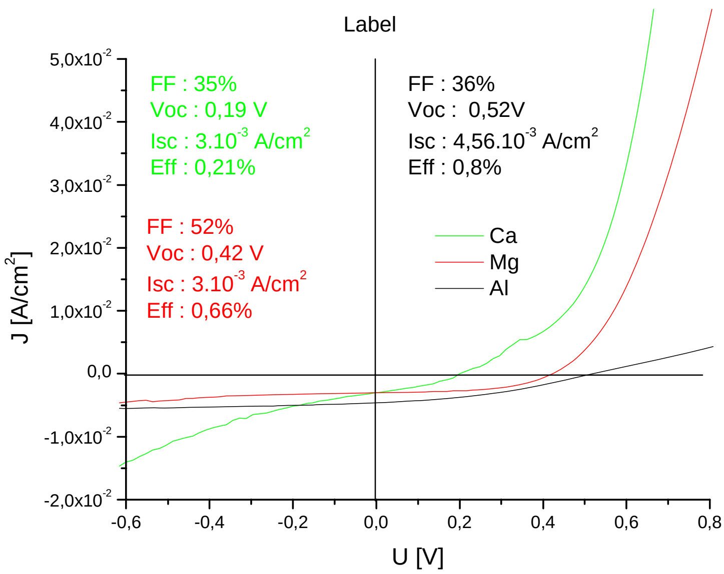

Figure 62. I/V curves of standard cells, with only difference the metal back-electrodes. All cells are produced on untreated ITO.

An interesting result, since by changing the work function of ITO with surface passivations we did not observe such significant change of the cell V_{oc}. A possible explanation is that the ITO work function change was not in that big range. We also changed the ITO work function to higher values and not to lower, as in the case with Ca and Mg. Figure 63 shows the values of work function for the three different metals Ca, Mg and Al [**69**,**70**].

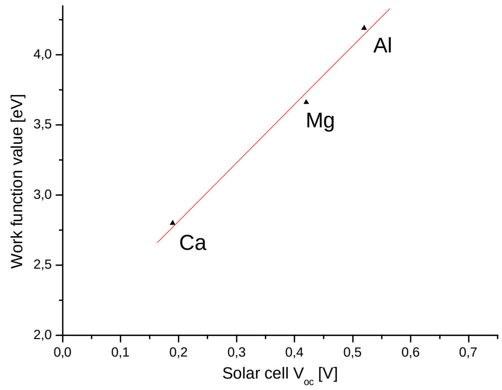

Figure 63. Plot of the work function of the metals Ca, Mg and Al against the corresponding solar cell V_{oc} achieved with these metals as back electrodes

The work function values of the three metals seem to be in the same order as the corresponding cell V_{oc} values. Moreover, the almost linear dependence of V_{oc} from the work function was not observed while changing the work function of ITO.

An explanation of the lower cell efficiency, with lowering the back-electrode work function can be sought in the band energy diagram of the interface, responsible for electron collection at that electrode (Figure 64).

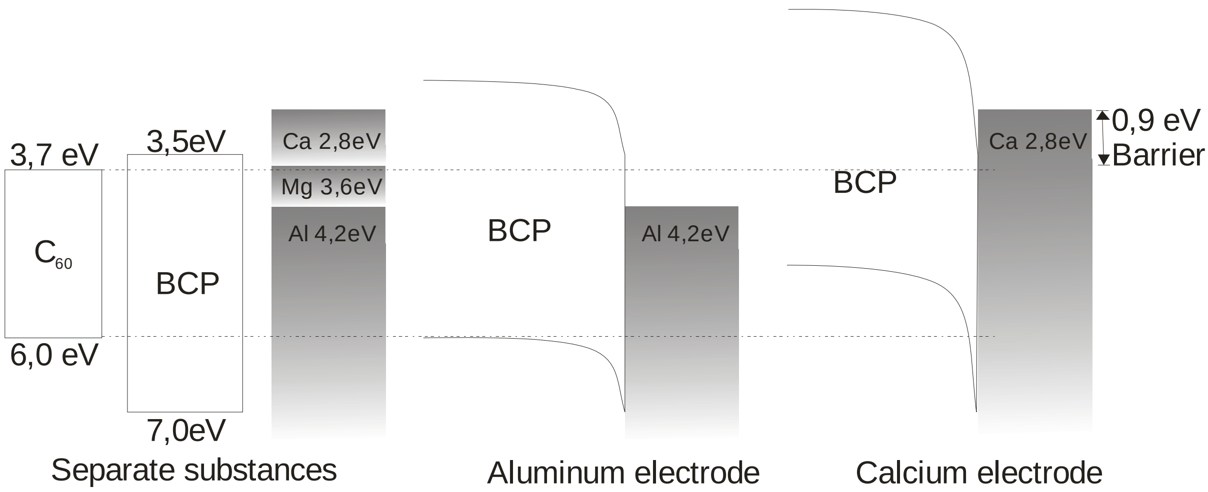

Figure 64. Band diagram section, visualizing the interface between back contact and C60, through the BCP buffer. Bending of the bands of BCP favors electron transport to Al, but creates an energetic barrier with Ca, as a back-contact (similar to Mg, not shown on the figure). Values for C60 are obtained from [59] as measured by us, and differ from the ones shown on the general cell energy band diagram from literature, shown in 1.3

The energy band diagram illustrates the bending of the energy bands of the organic buffer in contact with the back-electrode. In the case of aluminum as a back-electrode, a smooth passage for electrons coming from the acceptor layer is possible. Changing the electrode to a metal with lower work function, creates an energy barrier (of 0,9 eV, in the case of Ca), which suspends the electron transport to the Fermi level of the metal electrode.