Series resistance ($R_s$) was well-known as a key factor that affects the *FF* of a device.[33] $R_s$ mainly composed of the resistance of the conductive glass, the resistance of the electron transport within $TiO_2$ and the bulk resistance of the electrolyte. The following five equations revealed the relationship between *FF* and the $R_s$.[33] In equation (S1), $R_{ch}$ represented the characteristic resistance of the solar cell. In Equation (S2), $R_s$ and $r_s$ represented the series resistance and the normalized series resistance, respectively. In equation (S3), $v_{oc}$ was defined normalized $V_{oc}$, *k* is Boltzman's constant and T is the temperature in Kelvin. In equation (S4), $FF_0$ was denoted as the idealized fill factor. [33]

$$R_{ch} \approx \frac{V_{oc}}{J_{sc}} \tag{S1}$$

$$r_s = \frac{R_s}{R_{ch}} \tag{S2}$$

$$v_{oc} = \frac{q}{nkT} * V_{oc} \tag{S3}$$

$$FF_0 = \frac{v_{oc} - \ln(v_{oc} + 0.72)}{v_{oc} + 1} \tag{S4}$$

$$FF = FF_0 * (1 - r_s) \tag{S5}$$

Based on the results of Table.2, set $n$=1, $T$=300 $K$, and it was known that $q=1.6*10^{-19}$, $k=1.38*10^{-23}$, after calculating of the equations above, the results was shown in Table. 3.

From equation (S1), value of $R_{ch}$ decreased with the increase of $J_{sc}$. Besides, the value of $R_s$ increased with $Alq_3$ coating. Then from equation (S2), the value of $r_s$ increased. Thus from equation (S5), the value of *FF* would decrease a lot with $Alq_3$ coating. However, the FF only decreased from 0.62 to 0.61, nearly without any change. It could be explained that from equation (S3), the idealized fill factor of device with $Alq_3$ coating was larger than the blank sample because enhancement of $V_{oc}$ and $R_s$ from the retarding of charge recombination shown in the EIS results. The two opposite effects of enhancing $FF_0$ increasing *FF* and bigger $r_s$ decreasing caused the FF did not change obviously due to equation (S5).