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The reaction equations of  $C_{12}H_{25}Si(OCH_3)_3$  alcoholysis (S1) and the  $\equiv$ SiOH condensation process (S2).

$$(C_{12}H_{25})Si(OCH_3)_3 + (CH_3)_2CHOH \rightarrow (C_{12}H_{25})Si(OH)_3 + (CH_3)_2CHOCH_3$$
 (S1)

$$\equiv SiOH + HOSi \equiv \rightarrow \equiv Si-O-Si \equiv +H_2O$$
 (S2)

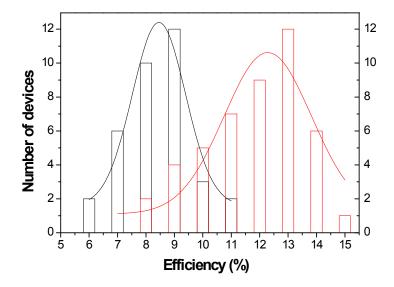


Figure S1. The efficiency distribution of the perovskite photovoltaic cells with (red bars, red fitting line) or without (dark bars, dark fitting line)  $C_{12}$ -Silane modification.

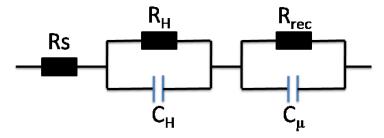


Figure S2. The equivalent circuit of the Nyquist plot. Rs represents the series resistance, One RC element ( $R_H$ ,  $C_H$ ) is related to the hole transport in spiro-OMeTAD, and the other one represents the recombination resistance (Rrec) and chemical capacitance ( $C\mu$ ) on the photoanode side.

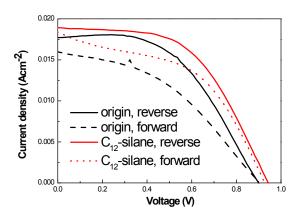


Figure S3. The hysteresis analyze of the original and  $0.1M\ C_{12}$ -silane modified perovskite solar cells.