Broader Context:

Typically, the task to obtain a stable graphene-based cathode consisting of low work function and excellent conductivity is generally more difficult to achieve compared to widely-reported graphene-based anodes, because n-type graphene devices have very limited thermal and chemical stabilities, and are usually sensitive to the influence of ambient environment. This work demonstrate a new concept of a "photoactive" graphene-heterostructure transparent electrode in which photogenerated charges from a light-absorbing material are transferred to graphene, resulting in the modulation of electrical properties of the electrode caused by a strong light–matter interaction at graphene-heterostructure interfaces. A "sunlight-activated" graphene/TiOx heterostructure transparent cathode was proposed and used to fabricate a high-performed *n*-graphene/*p*-Si Schottky junction solar cell that achieved a record-high power conversion efficiency because of unique photo-induced charge transfer at graphene/TiOx heterostructure interfaces. The breakthrough of discovering the sunlight-activated graphene-heterostructure transparent cathodes can be also applied in other photovoltaic systems which require a stable graphene-based transparent cathode consisting of low work function and excellent conductivity.