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Fundamental and applied aspects of nanocomposite photoanodes for photoelectrochemical cathodic protection

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Development of high-performance photo-electrical systems to utilize solar energy has enabled imminent applications. Recently, novel photoelectrochemical cathodic protection (CP) systems that use solar energy as the power source to enable the corrosion protection to metal structures have attracted much attention. In a photoelectrochemical CP system, a photoelectrode made of photosensitive materials acts as the anode and generates photoinduced electron-hole pairs under light illumination. In principle, the electrons in the valence band of an n-type semiconductor are excited into the conduction band under illumination, while holes are generated in the VB of the semiconductor. The photoinduced holes participate in anodic reaction on the photoelectrode. Photoelectrons transfer to the metal to be protected for cathodic reaction, resulting in cathodic polarization of the metal. Unlike conventional CP systems, the photoelectrochemical CP uses solar energy as the power source, and the photoelectrode is not consumable. This enables a sustainable, green technology for corrosion prevention of engineering structures in service environments that are usually corrosive. This talk summarizes the presenter's recent research achievements in development of photoelectrochemical CP for protection of steel pipelines from corrosion attack in the environments. Various photoelectrode materials were prepared to enable photoelectrochemical reactions under ultraviolet (UV) or visible light illumination with enhanced performance. Moreover, the nanocomposite photoelectrodes were fabricated to be able to self-store photoelectrons that can be released for corrosion protection in darkness.