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Tungsten oxide interlayer for hole injection in inverted organic light-emitting devices

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Currently, organic light-emitting diodes (OLEDs) have been proven of their readiness for commercialization in terms of lifetime and efficiency. In accordance with emerging new technologies, enhancement of light efficiency and extension of application fields are required. Particularly inverted structures, in which electron injection occurs at bottom and hole injection on top, show crucial advantages due to their easy integration with Si-based driving circuits for active matrix OLED as well as large open area for brighter illumination. In order to get better performance and process reliability, usually a proper buffer layer for carrier injection is needed. In inverted top emission OLED, the buffer layer should protect underlying organic materials against destructive particles during the electrode deposition, in addition to increasing their efficiency by reducing carrier injection barrier. For hole injection layers, there are several requirements for the buffer layer, such as high transparency, high work function, and reasonable electrical conductivity.

As a buffer material, a few kinds of transition metal oxides for inverted OLED applications have been successfully utilized aiming at efficient hole injection properties. Among them, we chose 2 nm of WO_3 between NPB [N,N'-bis(1-naphthyl)-N,N'-diphenyl-1,1'-biphenyl-4,4'-diamine] and Au (or Al) films. The interfacial energy-level alignment and chemical reaction as a function of film coverage have been measured by using in-situ ultraviolet and X-ray photoelectron spectroscopy. It turned out that the WO_3 interlayer substantially reduces the hole injection barrier irrespective of the kind of electrode metals. It also avoids direct chemical interaction between NPB and metal atoms. This observation clearly validates the use of WO_3 interlayer as hole injection for inverted OLED applications.