Silver nanowires as transparent conductive films in the near-infrared spectral range

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1. Introduction

Transparent conductive films (TCFs) comprise a crucial component of optoelectronic devices, such as displays, light-emitting diodes, solar cells and touch screens. Indium tin oxide (ITO) currently dominates among TCFs in the visible spectral range due to the high transmittance at low resistivity [1]. However, the remarkable decrease of the transmittance in the near-infrared range (NIR) restricts from using ITO as highly efficient NIR TCF. Here we show that silver nanowires (AgNWs) possesses up to 95% transmittance for whole 0.75-2.5μm near-infrared spectral range.

2. Discussion

AgNWs possess high transmittance in the visible spectrum range [2], however their transparency in the near-infrared range remained understudied. Figure 1 shows the transmittance of AgNW TCF compared to the ITO TCF and planar 30 nm thick Ag layer in the NIR. ITO remains highly transparent (>80%) up to 1.1 μm wavelength, then its transparency decreases

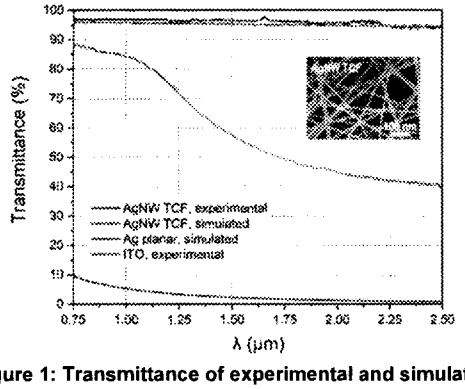

Figure 1: Transmittance of experimental and simulated AgNW TCF compared to simulated planar 30 nm thick Ag layer and experimental 164 nm thick ITO TCF. The diameter and length of AgNWs are ~30 nm and ~30 μm (aspect ratio ~1,000), respectively. Substrates (PET in case of AgNW TCF and glass in case of ITO TCF) were excluded from consideration. The inset shows the SEM image of AgNW TCF (scale bar 100 nm).

down to 60 and 40% at wavelength above 1.5 and 2.5 μm, respectively, due to increase of the reflectance and absorbance [3]. AgNWs reaches 95% for the whole 0.75-2.5μm range and exceeds the ITO TCF by 12.5, 37.8 and 55.2% for 1, 1.5 and 2.5μm, respectively.

Table 1. NIR transmittance of AgNW and ITO TCFs.

λ	AgNWs	ITO	$T_{AgNW} - T_{ITO}$
1μm	96.6%	84.1%	+12.5%
1.5pm	95.3%	57.5%	+37.8%
2.5μm	93.9%	38.7%	+55.2%

3. Summary

AgNWs benefit from strong optical transmittance across the whole 0.75-2.5μm range, which makes them particularly interesting for NIR optoelectronic applications. Compared to ITO TCFs, AgNW TCFs offer 12.5, 37.8 and 55.2% higher transmittance at 1, 1.5 and 2.5 μm, respectively.

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