Numerical studies on the performance of the percolation network for flexible transparent conducting electrodes under external deformation

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Comprehensive studies on the electrical characteristics of the percolation network of 1-D nanowires (NWs) under the external deformation are conducted by Monte-Carlo simulation based computational ways, and the tolerance of the performance against the deformation is investigated with respect to various factors. With the results, appropriate solutions are proposed to enhance the tolerance of sheet resistance (R_s) of the NW networks for the deformation such as bending and patterning. In addition, alternative methods are proposed to further improve the robustness of the R_s against the network deformation. Unidirectional arrangement of NWs toward bend axis and a hybrid network of NWs and 2-D sheet are introduced to alleviate the R_s degradation of the NW network due to outward bending of the network coated on a flexible substrate. In case of patterning of the NW network into a narrow channels with small feature size on the order of micrometer (comparable to the length of NWs), NW alignment in parallel to the channel and a mixed NW network with two types of NWs of different lengths present enhancement in the electrical performance. These numerical results can offer useful design guidelines for the use of the 1-D NW percolation networks in fabrication of flexible (or strechable) transparent conducting electrodes.

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