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Electrical Devices Including Dendritic Metal Electrodes

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Electrical structures which interact with light, such as solar cells and optical sensors, generally employ electrodes to collect a generated current (or to apply an external field), however, the electrode designs commonly used suffer from a number of disadvantages. For example, the wide spacing of electrodes in conventional solar cells, necessary to reduce electrode shadowing and limit manufacturing cost, results in high series resistance between the current generating areas and the current gathering electrodes. This resistance leads to inefficient energy collection, especially from the areas of the current generating structure that are farthest from the electrodes. Packing the electrode structures more tightly fails to provide a viable alternative because increasing the amount of electrode material will only shield the current generating material from the incident radiation, thereby significantly reducing efficiency and/or sensitivity. Accordingly, there exists a need for electrode designs that can provide optimal electrical properties while not blocking too much of the electrically active surface from light.

Researchers at Arizona State University have developed an electrically active structure involving a self-assembling electrode comprising dendritic metal elements formed on the exposed side of the structure. Due to its multi-branched mixed-scale nature, the dendritic metal electrode can effectively interact with a large area of the electrically active structure with minimal resistance and minimal occlusion of underlying layers. Moreover, dendritic metal structures can be relatively transparent when manufactured with nanoscale width and thickness; such low dimensionality can be achieved at low cost using self-assembly techniques.

Potential Applications

- Photovoltaic and Optoelectronic Devices (e.g. solar cells, optical sensors, liquid crystal devices, etc.)
- Displays and touchscreen modules as transparent electrodes

Benefits and Advantages

- Provides Both Reduced Resistance Current Collection and Reduced Occlusion of Underlying Layers ? makes technology suitable for top electrode use in electrical devices that photogenerate current (e.g. solar cells, photodetectors); dendritic metal structure can effectively interact with a large area of an electrically active structure without occluding a substantial portion of the structure?s area
- Offers Relative Transparency through Nanoscale Manufacturing ? low optical occlusion and high area coverage make it useful as an electrode in field-based optical devices

- Allows Relatively Simple, Inexpensive Fabrication ? able to fabricate devices using seld-assembly from a solid electrolyte (instead of micro- or nanolithographic processes)