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Dendritic Electrode Formation Via Liquid Overlayers

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. 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 electrical 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. This technology also can be used for displays, touch-screen technology, and photodetectors.

Potential Applications

- Photovoltaic cells
- Touch-screens
- Photodetectors
- Displays (LCD, LED, CRT, and Plasma)

Benefits and Advantages

- Provides both reduced resistance current collection and reduced occlusion of underlying layers
- 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 through self assembly
- Liquid overlayer process allows for fast dendrite growth, while reducing the necessary voltage bias from 30 V to just 5 V