Docket #: S15-105

Metal-dielectric hybrid surfaces as integrated optoelectronic interfaces with high optical transmittance and low sheet resistance

Stanford researchers at the Cui Lab have designed a self-aligned hybrid metal-dielectric surface that offers unparalleled performance in applications where both a transparent contact and a photon management texture are needed. Current applications include the front surface of solar cells, photodetectors, camera sensors, and LEDs.
The team has developed a prototype of silicon nanopillars protruding through a patterned gold film. Despite high metal coverage (> 60%), this design had extremely high absorption (>97%) and low sheet resistance of 16 Ohm/sq. This design can be easily implemented in multiple metal-semiconductor systems using a simple one-step fabrication process.

Video -"Invisible wires' could boost solar-cell efficiency"

Stanford News, November 25, 2015
"Stanford engineers develop 'invisible wires' that could improve solar cell efficiency"

Stage of Research

- Continued research on optimizing and scaling up, developing new catalysts and chemistries, and optimizing optical and electrical properties for different applications.

Applications

- Any front surface where photon management is required such as at the front surface of **solar cells, photodetectors, camera sensors, LEDs, and other optoelectronic devices**

Advantages

- **Optimized hybrid optoelectronic interface for maximum performance -** combines a photon management structure and transparent electrode in one design
- **Versatile** – can be used for any surface
- **Low sheet resistance** - significantly lower sheet resistance values than any technology currently available
- **Very efficient** - up to 97% absorption across 400-900nm light
- **Easy to implement**
- **Simple, one-step fabrication process** based on metal-assisted chemical etching (MACE)
- **Many different metal and materials stacks possible**
  - Silver, gold, copper, aluminum, platinum, palladium, rhodium
  - Si, GaAs, InP explored thus far

Publications

- V. K. Narasimhan, T. M. Hymel, R. A. Lai, and Y. Cui. "Hybrid Metal–Semiconductor Nanostructure for Ultrahigh Optical Absorption and Low Electrical Resistance at Optoelectronic Interfaces," ACS Nano ASAP, 2015

Patents

- Issued: 9,537,024 (USA)

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