# PAD

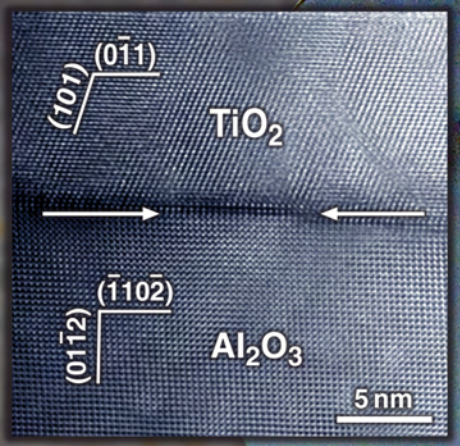
## Polymer-Assisted Deposition of Metal-Oxide and Metal-Nitride Films

Deposits films of nearly any metal oxide and metal nitride on most substrates and nearly any shape

Uses a water-based solution applied by dipping or spin-coating

Does not require a vacuum system

Reduces the cost and complexity of making flat-panel displays, microchips, solar cells, and superconducting tapes




Los Alamos
NATIONAL LABORATORY

**Licensable Technologies**

# PAD: Polymer-Assisted Deposition of Metal-Oxide and Metal-Nitride Films

## Applications:

- Wide Band Semiconductor
  - LEDs
  - Lasers
  - Opto-electric materials and components
- Hardness
  - Steel Coating
  - Tool Coating
- Conductive
  - Microelectronics

## Benefits:

- Control exact stoichiometry of nitride in the thin film
- Does not crack as is traditional with sol-gel processes
- Uniform and homogeneous film thickness
- Much cheaper than vacuum-related deposition processes
- Control of structure of film
  - Amorphous
  - Composite
  - Polycrystalline
  - Nanocrystalline
  - Microcrystalline
  - Epitaxy

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## Summary:

Metal-oxide and metal-nitride films are essential parts of semiconductors. These types of films can also have benefits as coatings that are resistant to a number of environmental effects. Unfortunately, growing metal-oxide and metal-nitride films requires large, expensive equipment. Capital costs for a single metal-oxide or metal-nitride film deposition machine can run from $500,000 to $3.5 million, and only very small films can be grown using traditional methods. Los Alamos National Laboratory (LANL) has developed a simple process for using polymers to grow large quantities of high-quality metal-oxide and metal-nitride films. Rather than spray a precise amount of material in a high vacuum (which requires the expensive equipment), we solubilize the metal oxides and metal nitrides in inexpensive polymers, then bake off the polymer, leaving a uniform thin film of metal oxide deposited on the substrate.


*A researcher applies a few drops of a water-based PAD solution to a silicon wafer mounted on a spin-coater.*

LANL's process is equivalent in quality to industry-standard chemical vapor deposition, yet much cheaper. Polymer-assisted deposition (PAD) is cost effective and can be used to cover much larger areas of substrates with metal-oxides and metal nitrides. PAD is also superior to sol-gel methods because PAD can be used with many more metal oxides and metal nitrides; the thin film is uniform and not susceptible to cracking; and because the metal oxide stoichiometry can be precisely controlled. Currently, the semiconductor industry spends $990 million annually on vacuum-based thin-film deposition machines. Another $260 million are spent for thin-film deposition machines outside the semiconductor industry. Thus, the total addressable market is roughly $1.25 billion. PAD could form the core of a business based on either a pure licensing model or a direct-sales-to-industry model.

## Development Stage:

We have demonstrated that PAD works with a wide range of metal-oxide and metal nitride films. Simply put, "problematic" metal oxides and metal nitrides are not a problem for PAD. It appears that PAD can be used generally for the high-quality deposition of metal oxides and metal nitrides for the successful production of both simple and complex metal-oxide films:

- $TiO_2$
- ITO
- $SrTiO_3$
- TiN, AlN and GaN
- Nitrides, sulfides, and carbides could potentially be developed using this process.

**Intellectual Property Status:** Patent pending

**Licensing Status:** The Laboratory has exclusive and non-exclusive licenses available for these technologies.

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