

# UNCD: Tuning Materials Properties via Plasma Chemistry

## UNCD synthesis is via Microwave CVD

- Growth Mechanism: C<sub>2</sub> dimer insertion
- 2-5 nm grain sizes; atomically-abrupt grain boundaries; conformal coating
- Phase-pure (<3% sp<sup>2</sup>-bonded carbon)

## Control of Plasma Chemistry: Manipulation of growth precursors

- Source gas additions (N<sub>2</sub>, H<sub>2</sub>, B<sub>2</sub>H<sub>6</sub>, PH<sub>3</sub>)
- Plasma Power and Biasing

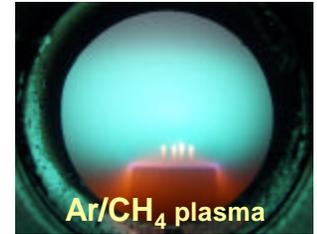
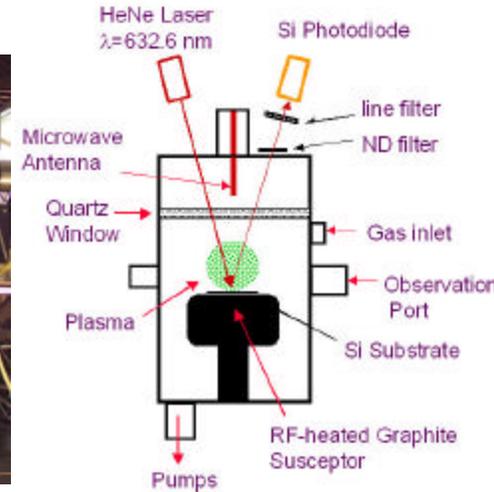
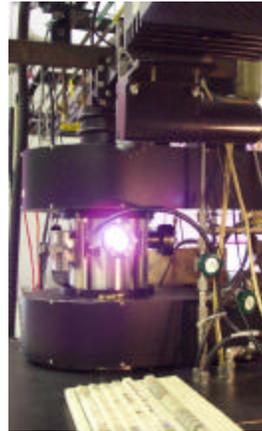
## Control of Structural Properties

- Grain size, grain boundary structure
- Surface/Interface Morphology

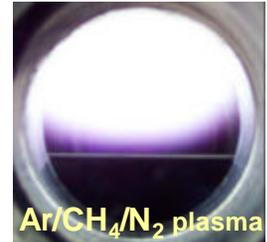
## Control of Electronic Properties

- N doping: UNCD becomes semi-metallic with grain boundary conductivity
- N,B,P Doping: in-situ controlled n- and p- type doping of UNCD

MPCVD



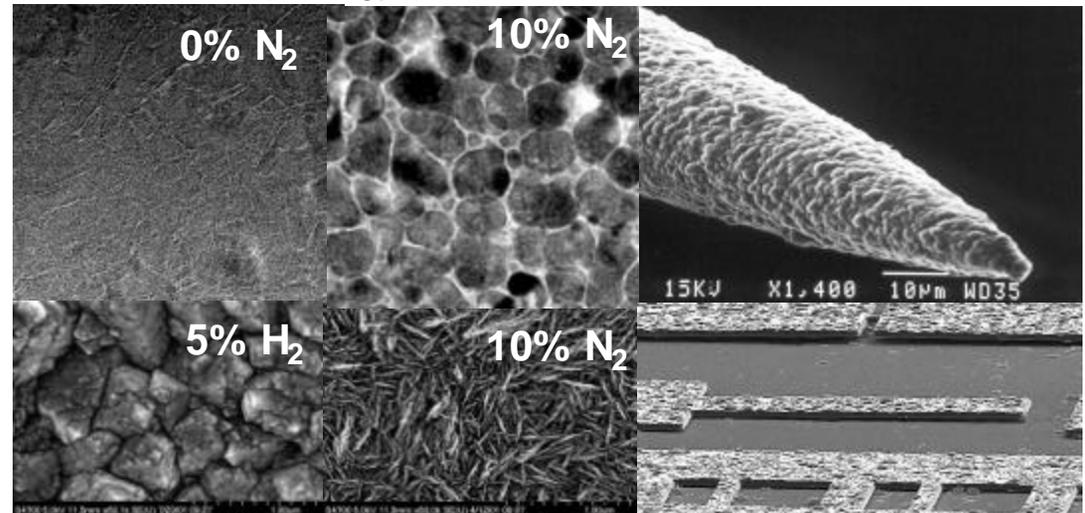
Ar/CH<sub>4</sub> plasma



Ar/CH<sub>4</sub>/N<sub>2</sub> plasma

Bulk Morphology (HRTEM)

Conformal Coatings

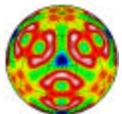


Surface Morphology (SEM)

UNCD-MEMS

*N,B,P Doping: High Speed, High temp. electronics*

*N,H doping: Mechanical, Tribological, Emission properties*



Basic Energy Sciences



ANL-MSD

Surface Chemistry Group (57504)  
Materials Science Division