For submission to the *Materials Research Society Fall 2007 Meeting,* Boston, MA SAND2007-5274C
November 26 – 30, 2007

Lithographically Defined Microporous Carbon Films:

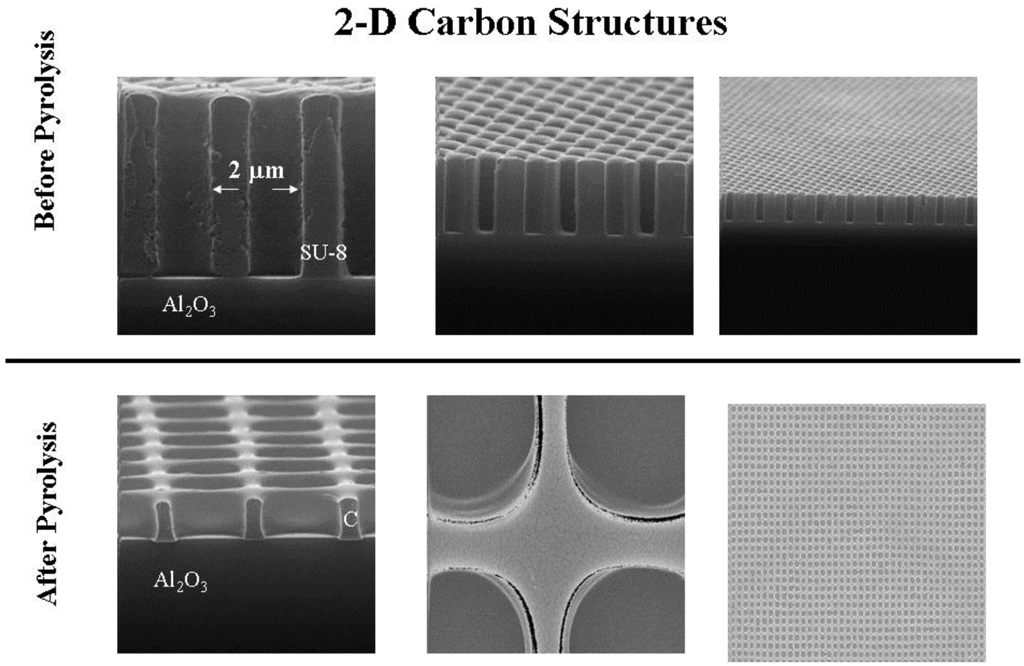
D. Bruce Burckel and Hongyou Fan
Sandia National Laboratories, Albuquerque, NM 87185-1349

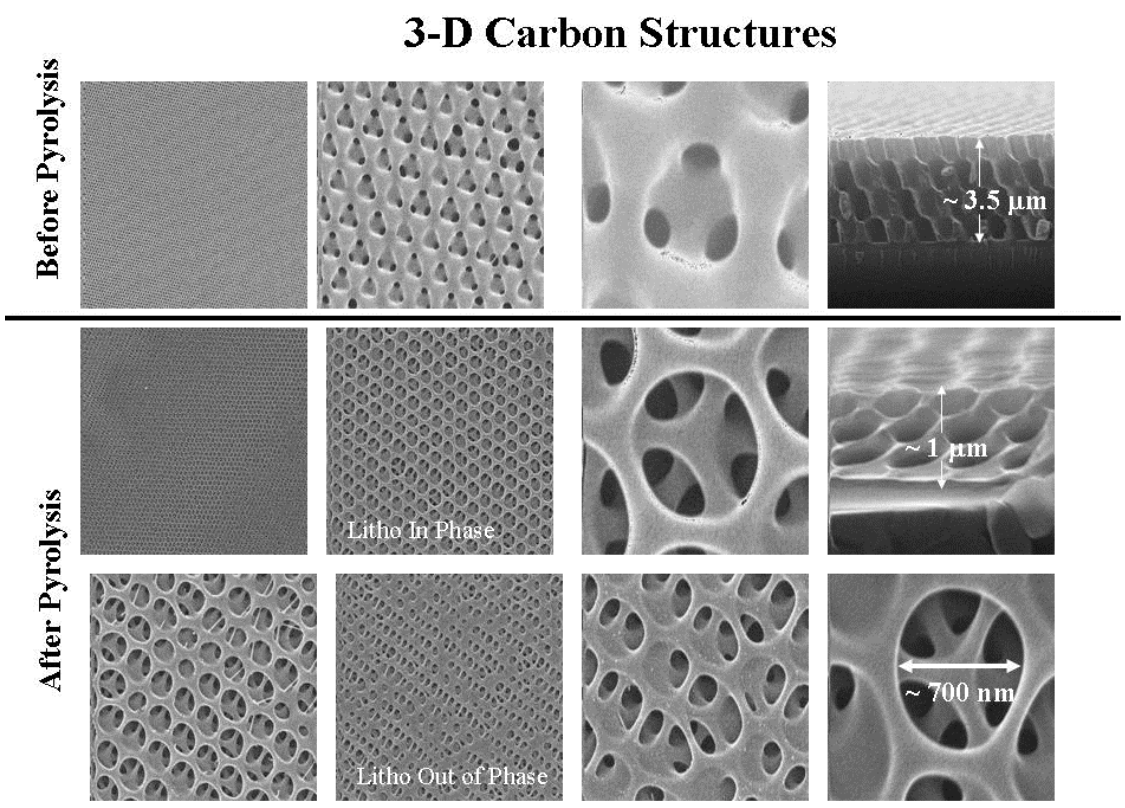
The special nature of the C-C bond found in materials such as graphitic or amorphous glassy-carbon, fullerenes (such as buckyballs) and carbon nanotubes makes carbon films a highly attractive material for use in many battery, catalysis and fuel cell applications. In addition to the intrinsic material properties of carbon, functionalized films can be produced through chemical modification of the C-C bond using a wide range of chemistries. Because of this flexibility and utility, fabrication of both macro and micro porous carbon films, with their commensurate increase in surface area, continues to receive significant research interest due to the high pay-off of increasing surface area and increased functionality.

We report a fabrication method capable of producing large area (~ 10's cm^2) submicrometer porous carbon films. Interferometric lithography (IL) is a maskless lithography approach where an actinic coherent laser beam is split and recombined forming an interference pattern. In our approach, this resulting interference pattern is used to pattern thick photoresist structures (~20 μm) in either 2-D arrays of holes, or 3-D periodic lattices. These structures are then converted to carbon via pyrolysis under flowing forming gas. During pyrolysis, the non-carbon species in the resist polymer backbone are removed, while the carbon remains. The patterned structures undergo significant shrinkage, but remarkably maintain their integrity and adhesion to the substrate. The degree of carbonization is a function of the pyrolysis temperature, with films ranging from insulating (< 400 °C) to near glassy-carbon-like conducting films (> 1000 °C).

These patterned films combine wavelength scale patterning, engineered electrical conductivity, and tailored material absorption, all properties which can be expected to interact with incident electromagnetic fields in interesting ways. We provide a detailed account of the optical (UV-Vis and IR), electrical and electrochemical properties of planar films as a function of pyrolysis temperature as well as characterization of the optical properties of structured films.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.


2-D Carbon Structures
Before Pyrolysis
2 μm
SU-8
Al2O3
After Pyrolysis
C
Al2O3


3-D Carbon Structures
Before Pyrolysis
~ 3.5 μm
After Pyrolysis
Litho In Phase
~ 1 μm
Litho Out of Phase
~ 700 nm