

Deposition of taC and taC:N Films by a Single Filtered Cathodic Vacuum Arc Source for Use as a Novel Electrode Material

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Introduction

Tetrahedral amorphous carbon (taC) and tetrahedral amorphous carbon incorporating nitrogen (taC:N) are interesting materials with various applications,¹ including electrochemistry.²⁻⁶ Films of taC:N exhibit many of the desirable properties of boron doped diamond (BDD) in regards to the electrochemistry. However these diamond-like films can be prepared under ambient conditions whereas BDD films require high substrate temperatures (850-900°C) and difficult nucleation. The ambient conditions allow for a much wider range of substrates and provide a surface finish smooth on the atomic level, in contrast to the microcrystalline nature of BDD. In particular, taC:N is compatible to applications such as microelectronics and microelectromechanical systems (MEMS).

The effects of such properties such as nitrogen content, ion energy, and other conditions on the electrochemical behavior of these films need to be explored. By identifying the properties imparted by the deposition conditions, these diamond-like films can be tailored for the desired electrochemical properties in various applications.

Experimental

Films of taC and taC:N are prepared in a high vacuum chamber (base pressures range from 5×10^{-8} to 3×10^{-7} torr) using a commercially available FCVA source (RHK Arc 20), as shown schematically in Figure 1. The nitrogen content of the films range from 0% (taC) to around 10% (taC:N) and are dependent on the partial pressure of nitrogen in the deposition chamber. The partial pressure of nitrogen is controlled by the inlet of nitrogen gas through a leak valve (closed for taC deposition) and is monitored using an ion gauge. These films have been successfully deposited on a variety of substrates such as Ta or Ti foils, electrochemically roughened Ag foil, and Si wafers. The ion energy is controlled by biasing the substrate with an external power supply.

Results and Discussion

Electrochemical results are discussed elsewhere at this meeting.⁷ SERS (Surface Enhanced Raman Spectroscopy) performed on taC and taC:N films deposited on the electrochemically roughened Ag foil will be presented. The SERS spectra are useful in comparing the D:G peak ratios which reflect the $sp^3:sp^2$ ratio of the films. Analytical results on the nitrogen content were obtained by x-ray photoelectron spectroscopy.

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References

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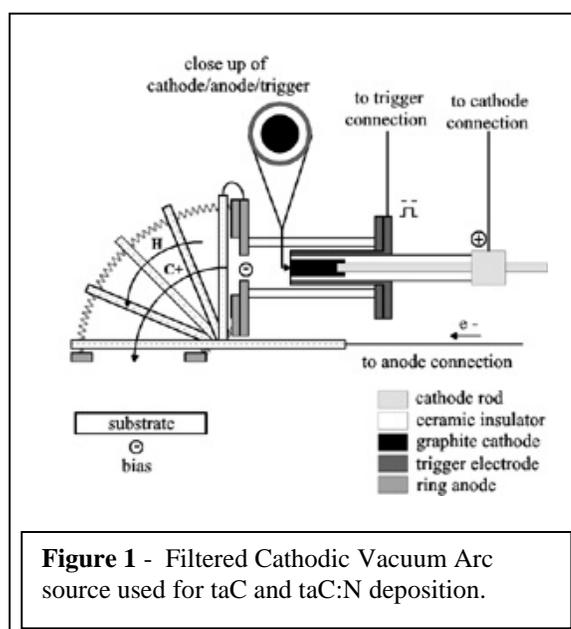


Figure 1 - Filtered Cathodic Vacuum Arc source used for taC and taC:N deposition.