Structural stability of hydrogenated amorphous carbon overcoats used in heat-assisted magnetic recording investigated by rapid thermal annealing

N. Wang and K. Komvopoulos*
Department of Mechanical Engineering, University of California, Berkeley, California 94720, USA

F. Rose and B. Marchon
Hitachi Global Storage Technologies, A Western Digital Company, San Jose, California 95135, USA

Abstract

Ultrathin amorphous carbon \( (a\text{-}C) \) films are extensively used as protective overcoats of magnetic recording media. Increasing demands for higher storage densities have necessitated the development of new storage technologies, such as heat-assisted magnetic recording (HAMR), which uses laser-assisted heating to record data on high-stability media that can store single bits in a very small area (~1 Tbit/in\(^2\)). Because HAMR relies on locally changing the coercivity of the magnetic medium by raising the temperature above the Curie temperature for data to be stored by the magnetic write field, it raises concerns about the structural stability of the ultrathin \( a\text{-}C \) film. In this study, rapid thermal annealing (RTA) was used to examine the thermal stability of ultrathin hydrogenated amorphous carbon \( (a\text{-}C:H) \) films deposited by plasma-enhanced chemical vapor deposition. Structural changes in the \( a\text{-}C:H \) films induced by RTA were studied by x-ray photoelectron spectroscopy, Raman spectroscopy, x-ray reflectivity, and conductive atomic force microscopy. It is shown that the films exhibit thermal stability up to a critical temperature in the range of 400–450 °C. Heating above this critical temperature, results in the depletion of hydrogen and the enhancement of \( sp^2 \) clustering. The determined critical temperature represents an upper bound of laser heating in HAMR hard-disk drives and provides a limit for the Curie temperature of magnetic materials used in HAMR.

Keywords: carbon atom hybridization, heat-assisted magnetic recording, hydrogenated amorphous carbon, rapid thermal annealing, spectroscopy, structural stability, ultrathin films

*Corresponding author: Tel: (510)-642-2563, Fax: (510)-643-5599, E-mail: kyriakos@me.berkeley.edu