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# Structural Changes Induced by Thermal Annealing in Cr/C Multilayers

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## Abstract

The structural changes induced by thermal annealing in Cr/C multilayers were investigated. Cr/C multilayers with period thickness of 5 nm and bi-layer number of 30 were deposited by direct current magnetron sputtering, and characterized by using grazing incidence X-ray reflectivity, X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy. The results suggest that the period thicknesses of Cr/C multilayers expand or contract with different carbon layer thickness ratios (the ratio of the carbon layer thickness to the multilayer period) upon annealing and the physical mechanism was explored in detail. Carbon layer in Cr/C multilayers become graphitized from amorphous state. Such graphitization of the carbon layer causes a decrease in its density, thus an increase in its thickness. The annealing process also causes a reduction in period due to the formation of denser carbide, which can be confirmed by the XPS results.

**Keywords:** Cr/C multilayer, interface, thermal effects, Raman spectroscopy, X-ray photoelectron spectroscopy, X-ray reflectivity

## 1. Introduction

Multilayer mirrors are widely used as optical elements for applications such as extreme ultraviolet (EUV)

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