Analysis of mechanism of carbon removal from GaAs(1 0 0) surface by atomic hydrogen

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1. Introduction

It is known that carbon is strongly bonded to the III–V surfaces and for this reason the carbon contamination is very hard to remove [1–5]. Unfortunately, these carbon impurities, commonly found on the III–V surfaces, adversely affect the growth and quality of MBE layers [3–5] resulting in surface morphology deterioration even for buffer layers with thickness of up to 100 nm [2,3]. Thus, removing of carbon contaminations is strongly desired, since it is suggested that the presence of carbon at the growth interface is a major origin of carrier depletion [4].

Recently, the behavior of hydrogen atoms, frequently called hydrogen radicals, at semiconductor surfaces has attracted the attention of scientists as an important subject in gas-phase semiconductor processes [6–10]. Among different approaches, many papers have also addressed specifically the utilization of atomic hydrogen for the low-temperature cleaning of semiconductor surfaces [8–14].

In spite of significant progress in smooth and high-quality surface production [15–19], very little is currently understood at the atomic level concerning the chemical processes responsible for the contaminations removal. For example, some authors have demonstrated that it is possible to remove carbon from the surface by room temperature atomic hydrogen irradiation [2,8,20] whilst others [4,9,12,13] claimed that it is impossible.

With respect to the abundance of inconsistent experimental data, we revisit the role of atomic hydrogen irradiation in carbon film removal from the GaAs(1 0 0) surface, not only of its importance for epitaxial growth by molecular beam epitaxy (MBE) of high-quality thin films, but also for academic reasons.

The objectives of these studies are to reveal the etching process during atomic hydrogen irradiation of the GaAs(1 0 0) surface, and to provide a basic theoretical interpretation for the differences in the degree of etching between different carbon contaminations. Thus, in this paper we focus our attention on the first interaction stage of the atomic hydrogen interaction with the native surface.