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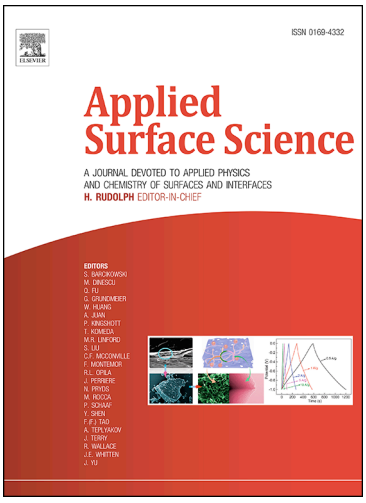

Full Length Article

Nanoscale etching of III-V semiconductors in acidic hydrogen peroxide solution: GaAs and InP, a striking contrast in surface chemistry

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Nanoscale etching of III-V semiconductors in acidic hydrogen peroxide solution: GaAs and InP, a striking contrast in surface chemistry

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Abstract

In this study of nanoscale etching for state-of-the-art device technology, the importance of surface chemistry, in particular the nature of the surface oxide, is demonstrated for two III-V materials. Striking differences in etching kinetics were found for GaAs and InP in sulphuric and hydrochloric acidic solutions containing hydrogen peroxide. Under similar conditions, etching of GaAs was much faster, while the dependence of the etch rate on pH, and on H_2O_2 and acid concentrations also differed markedly for the two semiconductors. Surface analysis techniques provided information on the product layer present after etching: strongly non-stoichiometric porous (hydr)oxides on GaAs and a thin stoichiometric oxide that forms a blocking layer on InP. Reaction schemes are provided that allow one to understand the results, in particular the marked difference in etch rate and the contrasting role of chloride in the dissolution of the two semiconductors. A critical factor in determining the surface chemistry is considered to be the ease with which a proton can be removed from the group V hydroxide, which is formed in the initial etching step (the breaking of the III-V surface bond).

Keywords: nanoscale etching, GaAs, InP, reaction mechanisms, surface chemistry, III-V oxide