Photoassisted anodic etching of n-InN films in an AGW electrolyte

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Indium nitride (InN) electrochromic films are applicable to optical switching devices, such as sunglasses and antiglare mirrors. Wet etching is one of the critical processing in device fabrication. To date, Guo et al.[1] reported on the chemical etching of InN films with an NaOH electrolyte at room temperature. However, there have been no report on the photoassisted anodic etching of InN films. Anodic etching is an important wet etching method, involving the electrochemical process. In this study, we report photoassisted anodic etching of InN films using a mixed solution of ethylene glycol and water (AGW). Anodic oxidation in the AGW electrolyte has been used as a reproducible means to form an oxide layer on InP, GaAs,[2,3] and GaN.[4] Ultraviolet (UV) light was employed to generate electron - hole pairs in InN films to aid the etching process in the AGW electrolyte.

InN films were grown on glass substrates at 50 ℃ for 3 h using rf ion plating. The thicknesses of the InN films were about 1.7 μm. These films have polycrystalline structure with a preferred orientation of 101. The AGW electrolyte used in this study was a mixture of a buffered aqueous solution of tartaric acid and ethylene glycol.[5] An InN electrode was used as an anode and a Pt electrode was used as a cathode. Using a DC voltage supply, a constant current was supplied between these electrodes through the AGW electrolyte. The UV source was a 500 W super high pressure mercury UV lamp.

In order to investigate whether InN films could be chemically etched with the AGW electrolyte without any current passed through the sample and UV irradiation, we carried out chemical etching of InN films at first. No significant etching of the InN film was observed after 10 h. When the current was maintained at 3 mA/cm^2 without UV irradiation, no etching of the InN film was observed in the AGW electrolyte, and it was observed that there was a white layer of indium oxide on the InN film which seemed to block etching as shown in Fig. 1. To clarify how UV irradiation affects electrochemical etching of the InN film, the electrochemical etching of InN films under the condition of both UV irradiation and a current passing through was attempted. Figure 2 shows a SEM image of an InN film etched at 3 mA/cm^2 in the AGW electrolyte under UV irradiation. We have found that InN films can be electrochemically etched by photoassisted anodic etching using the AGW electrolyte. Furthermore, the etched InN surface was smooth from the observation of SEM. When pure ethylene glycol was used as a solution, no current passes through the solution. Without ethylene glycol no significant etching of the InN film was observed. From these results it is considered that ethylene glycol acts as a chelating agent for In,[6] resulting in dissolution of indium oxide with UV irradiation.

In conclusion, we have found that InN films can be etched by photoassisted anodic etching using the AGW electrolyte. For InN films, ethylene glycol plays an important role in photoassisted anodic etching using the AGW electrolyte.

References

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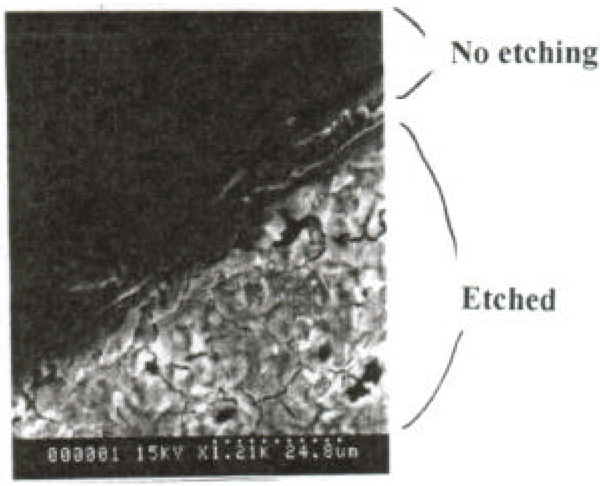

Fig. 1. SEM image of the surface morphology of an InN film after anodic etching without UV irradiation. The unetched surface was covered with apiezon wax during etching.

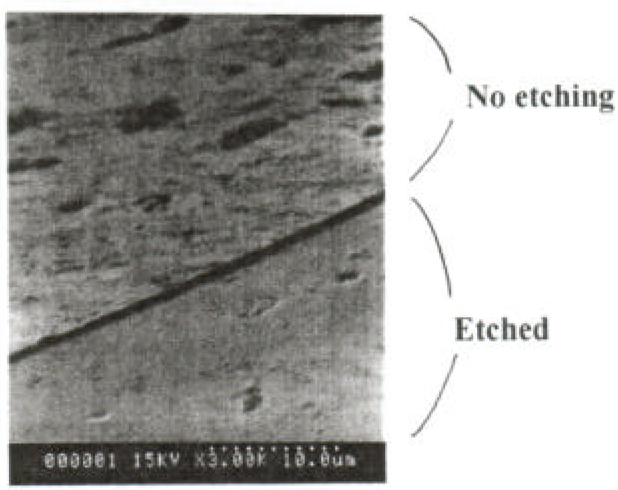

Fig. 2. SEM image of etched surface after photoassisted anodic etching of an InN film.