

Visible Photoluminescence from Anodized p-type  
InP(100) and n-type GaP(100)

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In recent years, the localized dissolution of semiconductors has generated a great deal of renewed interest as a result of the discovery of light-emitting porous Si (see, e.g., the references in [1-4]). For other semiconductor materials such as the III-V compounds, research on localized dissolution has also increased in the last few years (see, e.g., the references in [3]).

The anodization of p-type semiconductors in acidic solutions, leads normally to electropolishing of the surface. However, it is well known for Si only that in HF containing solutions porosification can take place [5]. In this work it was found that by a potentiostatic anodic polarization of p-type InP in 1 M HF instead of electropolishing a modification of the surface occurs. The experiments showed that it is possible to form a surface layer that exhibited blue, red and yellow colours. By applying higher anodic potentials or using longer polarization times the shiny rainbow-like colours on the surface change into a dull yellow. The SEM image of the rainbow coloured surface shows some nanosized pores on top [Fig. 1(a)], while the dull yellow surface consists of big porous particles [Fig. 1(b)]. The particles were identified as a mixture of different indium and phosphorous oxides, and the rainbow coloured surfaces also showed a composition of these oxides, but with a different ratio. As a result of previous work on the porosification of n-type InP, where different pore morphologies appeared by using different halogenic acids [6], polarization of p-type InP was also carried out in HCl and HBr. While in HBr under certain circumstances pore growth into the bulk material was obtained, in HCl there always occurred only an electropolished surface. Room temperature photoluminescence (PL) measurements (Fig. 2) show a bright visible PL with two peaks in addition to the strong bulk InP peak, one between 650–700 nm and a second peak at around 530 nm. The origin of the second peak is ascribed to transitions between the different oxides formed on the surface, while the nature of the first peak is at the moment unknown. From TEM examination it was found that no InP particles were embedded within the thin oxide layer, so that the PL cannot be a result of the quantum confinement of carriers in InP.

For n-type GaP, a sponge-like structure, as determined by SEM (Fig. 3) and Raman scattering, was obtained on the surface after electrochemical etching in 1 M KCl under illumination. Such samples produced a bright green-yellow PL peaked at 533 nm (2.33 eV), which is slightly above the bulk GaP indirect band gap of 2.27 eV.

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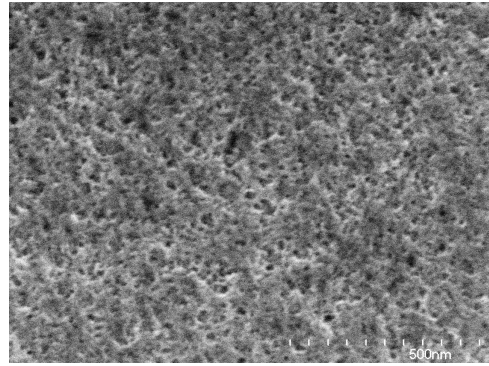


Fig. 1(a): Porous oxide formed on p-InP in 1M HF after polarization at 1000 mV for 20 min.

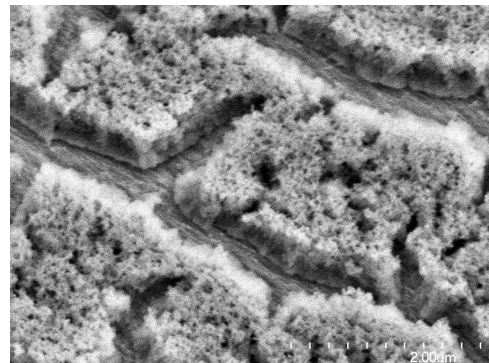


Fig. 1(b): Porous oxide formed on p-InP in 1M HF after polarization at 3000 mV for 5 min.

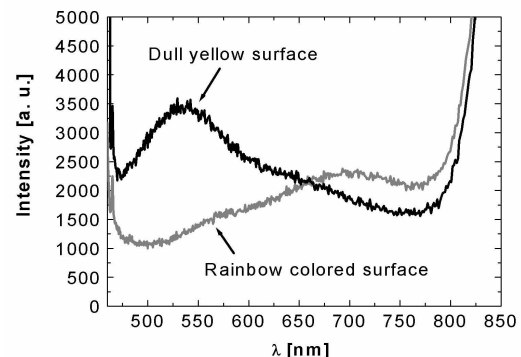


Fig. 2: PL spectra of p-InP after polarization in 1 M HF at 1000 mV for 20 min (rainbow coloured surface) and at 3000 mV for 5 min (dull yellow surface).

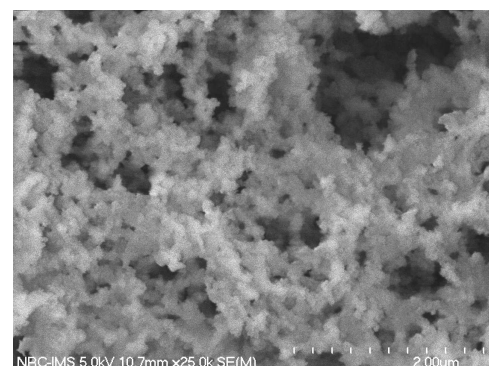


Fig. 3: SEM image of n-GaP after polarization in 1 M KCl from -0.5 V to +20 V (potential sweep 20 mV/s).