RECENT DEVELOPMENT OF ADVANCED InP ETCHING IN AN INDUCTIVELY COUPLED HIGH DENSITY PLASMA

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Common issues of conventional InP reactive ion etching includes low rate and poor uniformity. Typical etch rate of CH_4/H_2-based etch process is ~ 500 A/min. In order to have a reasonable production yield with the low rate, a batch process has been popular. However, using a batch chamber for InP etching can bring uniformity issues. Uniformity is a significant issue for mass production. Etch rate can be changed from wafer to wafer as well as within the wafer in a batch process. With a fast scale-up of InP wafer size, a batch RIE may not be attractive any longer. Recently, we have developed two InP etch processes in an inductively coupled plasma (ICP) system. The system has 2 MHz-based high density ICP source. One is for high rate etching (≥1 um/min) of InP and the other is for relative moderate etching of InP (≥ 0.1 um/min). The former is quite useful for general pattern transfer process of InP. The process can be used to fabricate advanced devices for telecommunication, for examples, HBTs and HEMTs as well as optoelectronics, like LEDs and lasers. The process results shows that it is possible to achieve InP etching with an extremely clean surface, near vertical sidewall profile (> 88°) and good selectivity to SiO_2 (> 10:1). This process provides at least one order of magnitude higher etch rate that conventional RIE process, which can give a similar production yield with an excellent uniformity and reproducibility control of InP wafer compared to a batch RIE. We can further improve the production yield with an advanced wafer transfer system. A typical SEM photo of InP ICP etching is shown in Figure 1. The process is relatively high temperature process in order to minimize any volatility issue of InP-based materials (~ 140 °C on the electrode). The later is found to be quite useful for fabrication of InP lens for telecommunications. The important note of the later is that the process does not require any heating of the electrode. Helium backside cooling is also used to maintain the InP wafer temperature constantly low during processing. Therefore, photoresist can be used as a mask. Surprisingly, the process made it possible to find a breakthrough for InP lens fabrication, where sloped angle is critical for device manufacturing. This room temperature process has also excluded CH_4/H_2-based chemistry for InP etching. It allows to maintain a clean chamber and easy seasoning. The process provides reasonably good etch rate of InP (≥ 0.1 um/min). Figure 2 shows an SEM photo after InP etching with the ICP process for lens application. Please notice that, with a desirable selectivity (~1:1) to photoresist for lens application, the etched feature has an excellent slope of InP. The process may be utilized for pattern transfer of InP materials before regrowth or metal deposition, where obtaining sloped sidewall is quite desirable. We will present advanced InP ICP etching technologies with the recent breakthroughs in details.

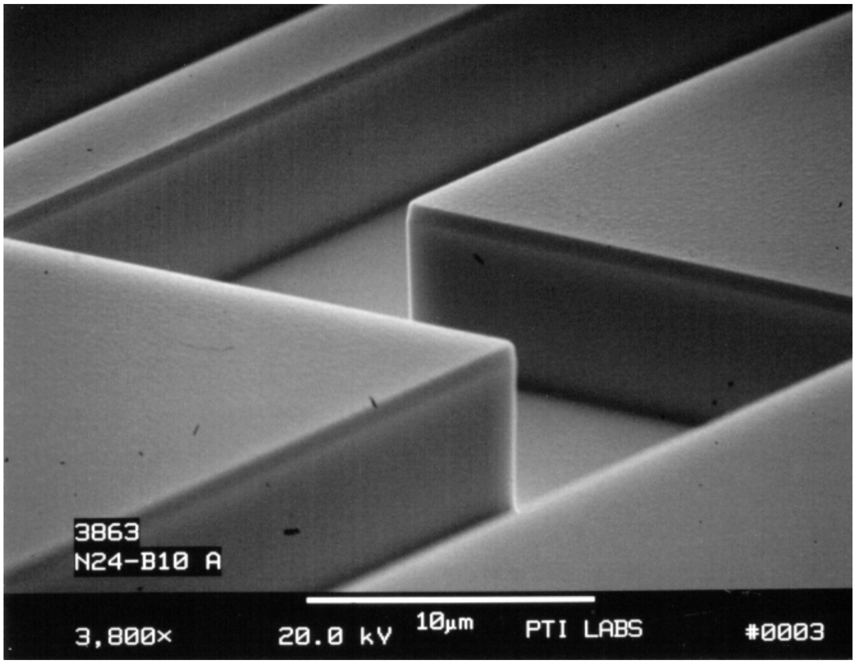

Figure 1. SEM photo of InP etched in an ICP plasma.

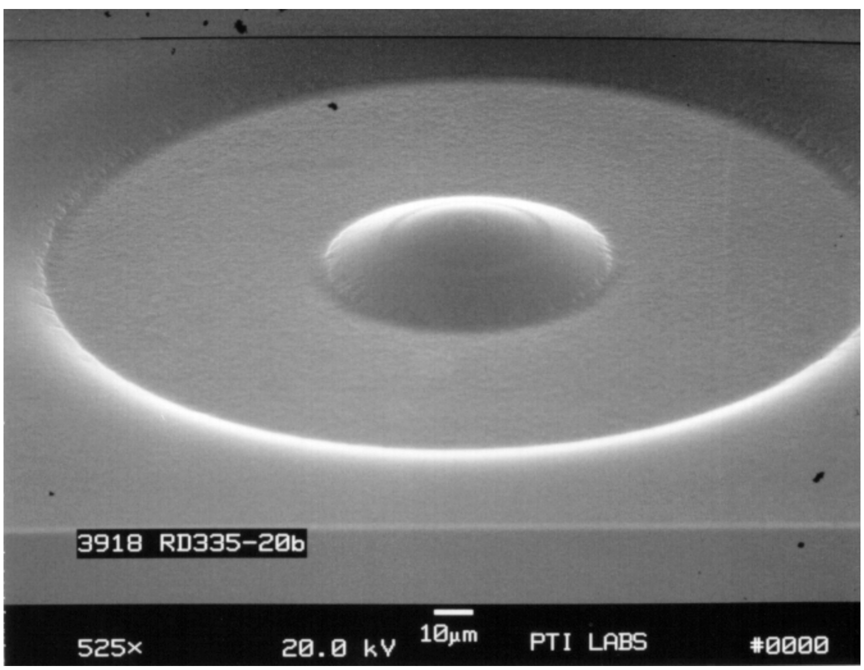

Figure 2. SEM photo of InP lens etched in an ICP plasma