

Large Area Etching for Porous Semiconductors

J. Carstensen, J. Bahr, K. Steen, M. Christophersen,
S. Langa, S. Lölkes, and H. Föll

Faculty of Engineering, Christian-Albrechts University,
24143 Kiel, Germany

Porous semiconductors are not only of interest for basic research but also for a wealth of applications in many different areas, for a recent review see [1]. While so far interest has been focused on porous Si, porous III-V compounds, as found more recently, have many unusual and potentially very useful optical properties and thus are of increasing interest for applications, too.

For practically all applications it is essential to anodize large areas. As far as Si is concerned, 200 mm and 300 mm wafers are the present day standard and any industrial etching process must be able to handle these sizes, either for compatibility with other processes needed on the wafer, or simply for reasons of costs and productivity.

While it is relatively easy, to etch all kinds of pores (micro, meso or macro) in all kinds of substrates (p, p+, n, or n+ type) under common conditions (low or high HF concentration, current densities, voltages; aqueous or organic electrolytes, with or without backside illumination), the same is not true for large area etching. This often comes as a surprise for researcher who simply scale up their small area equipment.

What makes a large area etcher fundamentally different from a small area lab-type etcher can be summarized in the following points:

- i) Large absolute quantities. While a current density of e.g. 200 mA/cm² in 49% HF does not pose any particular problems for small samples, it translate into running a current of 63 A or 141 A through several liters of extremely dangerous chemicals for 200 mm or 300 mm wafer, respectively. This brings up the second point:
- ii) Safety and reliability – imposing extremely tight limits on materials used and on cell design.
- iii) Absolute homogeneity of the etching is, of course, the most difficult requirement because it translates into homogeneous condition of electrolyte flow over large areas. The most difficult task concerning homogeneity is either electropolishing, or producing deep macropores in p-type Si with organic electrolytes. Micro- and mesopores, on the other hand, are far less demanding in this respect.
- iv) The backside contact is of overwhelming importance; Fig. 1 gives an example. If the backside is to be illuminated, serious problems are encountered and must be solved.

As far as the authors know, there are presently only three places (Canon, cf. [2], Infineon/Munich, cf. [3, 4], and our laboratory, cf. [1]) where 150 mm wafers can be etched under conditions that meet the requirements outlined above, a fourth design was reported by Philips, cf. [5], but seems to be abandoned.

The presentation discusses the large area etching strategies and systems as far as they are known, outlines the demands and difficulties in detail, and present and dis-

cusses various results from the large area etching apparatus of the authors.

References

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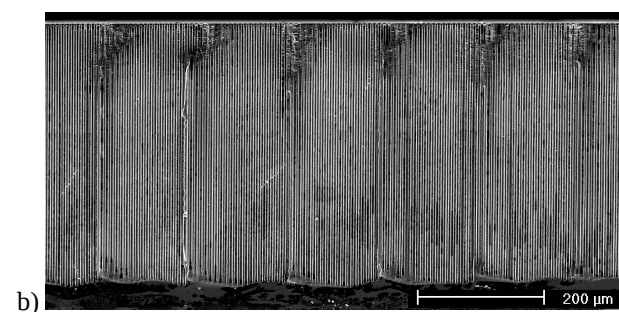
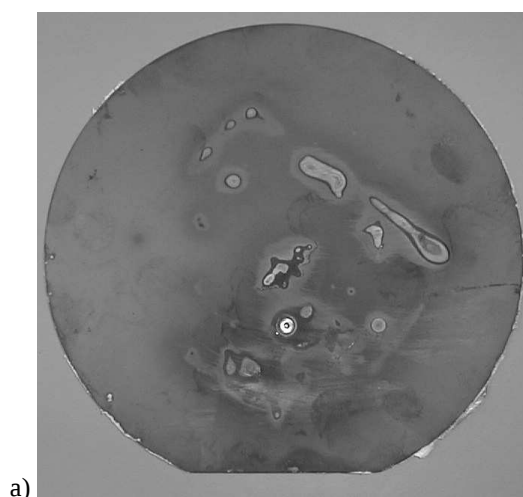


Fig. 1: Examples of large area etching experiments with an extremely homogeneous electrolyte flow on the front side but an inhomogeneous ohmic back side contact. a) Electropolishing a 150 mm <100> p-Si (5 Ωcm) in 4wt. % aqu. HF just using conventional InGa alloy as a large area backside contact b) 500 μm deep macropores etched in <100> n-Si (10 Ωcm) with backside illumination using 5wt.% aqu. HF. The backside contact in this case was made on small areas spaced at regular intervals, and the resulting pattern in the pore structure is clearly seen.