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Plasma etching of thick Parylene C for fabrication of biocompatible electrodes

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Here we report on the plasma etching of thick parylene C in order to define flexible implantable probes for neural applications. To reduce the foreign body response and to ensure a good stability for chronic *in vivo* recordings, the chosen substrate for the neural probes is Parylene C, a polymer known for its high biocompatibility, flexibility and chemical inertness [1]. In the manufacturing process, highly defined structuration steps of Parylene C are essential. Techniques based on laser, scalpel and wet etching have shown to be unsuitable for properly cut structures, *i.e.* with good dimensions control and without residues. As an alternative, plasma etching has shown great promise in this area [2]-[3]. However, because of the highly crystalline structure of this polymer, fast etching rate, lack of residues and high aspect ratios remain hard to achieve, especially for deep etching of thick layers.

One of the main difficulties to etch thick parylene (25 μ m) is to find the appropriate mask. As Parylene C is a polymer, the etching requires strong oxygen plasma that standard photoresists withstand poorly. Indeed, thick positive resist such as AZ40XT deteriorates rapidly with the thermal gradient, and the selectivity results insufficient. A metallic mask has also been tried out, such as nickel (Ni); however with Ni mask, residues have been found inside opening [4]. These residues are created by micro-masking due to metal sputtering during etching.

In order to remove these residues and to reduce the number of process steps due to Ni mask fabrication, a negative photoresist has been tested. BPN negative photoresist is ideally suited for the etching of thick Parylene C [5]. This thick resist (50-100 μ m) is easy to pattern in less than 30 minutes, and withstands plasma temperature, avoids micro-masking and is removed easily with solvent (even after strong plasma). For the first time, negative resist (BPN) coating followed by RIE-ICP are used in order to pattern Parylene C-based structures, with a clean cut, vertical profile and fast etching rate ($\sim 0.7 \mu\text{m}/\text{min}$).

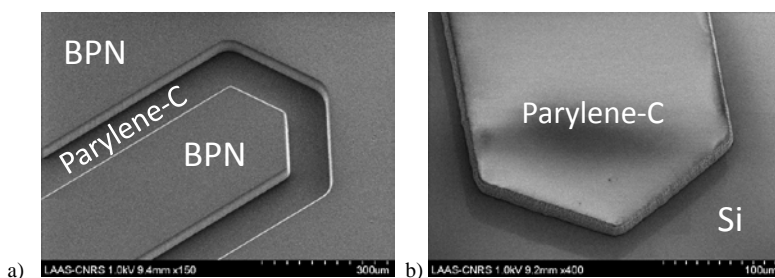


Figure 1. a) BPN mask on Parylene, b) after parylene etching: no residues inside openings

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