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(54) **PROCESS GAS FOR CRYOGENIC ETCHING, PLASMA ETCHING APPARATUS, AND METHOD OF FABRICATING SEMICONDUCTOR DEVICE USING THE SAME**

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(57) **ABSTRACT**

A method of fabricating a semiconductor device comprises forming a mold layer on a substrate, forming a hardmask layer on the mold layer such that a portion of the mold layer is exposed, and using the hardmask layer to perform on the mold layer a cryogenic etching process. The cryogenic etching process includes supplying a chamber with a process gas including first and second process gases, and generating a plasma from the process gas. Radicals of the first process gas etch the exposed portion of the mold layer. Ammonium salt is produced based on the radicals etching the exposed portion of the mold layer. The second process gas includes an R—OH compound. The R is hydrogen, a C1 to C5 alkyl group, a C**2** to C6 alkenyl group, a C**2** to C6 alkynyl group, or a phenyl group. The second process gas reduces a production rate of the ammonium salt.