ABSTRACT

A semiconductor device includes channels spaced apart from each other on a substrate in a vertical direction substantially perpendicular to an upper surface of the substrate, a gate structure on the substrate and bordering lower and upper surfaces and a first sidewall of at least a portion of each of the channels, and a source/drain layer on a portion of the substrate adjacent to the gate structure and contacting second sidewalls of the channels. A nitrogen-containing portion is formed at an upper portion of an uppermost one of the channels, and may be doped with nitrogen.

FIG. 4