Improved Short Channel Performance for 3D NAND Flash Memory

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Recently, the demand for 3D NAND flash memory has grown drastically due to its massive application in handhold devices such as smart phones, tablets etc. Further, to satisfy the present market need and to achieve desired compactness, flash memory devices are scaling to 1-X- nm generation. This scaling produces short channel effects such as threshold voltage roll-off, Drain Induced Barrier Lowering (DIBL) and Sub-threshold Swing (SS) in the flash memory device to affect the 3D NAND flash memory performance. Hence, investigation of new developments in the designing methods of 3D NAND flash memory to lower the short channel effects in flash devices will be of prime importance for future generation. In our research, we have discovered a novel channel engineering method to improve the short channel performance of 3D NAND flash memory. Importantly, retrograde channel doping as compared to uniform channel doping provides better short channel performance in junction-free 3D NAND flash memory. The retrograde and uniform channel doping is shown in Fig. 1(a) and 1(b) respectively. This phenomenon of improved short channel performance is attributed to the reduced intensity of fringing field interference from adjacent gates due to the presence of high doping density which opposes the field penetration. As a result, the spreading of the charge carrier from virtual S/D into the effective gate region reduces. This enhances the gate controllability over the channel through high gate electric field and hence improves the short channel performance.

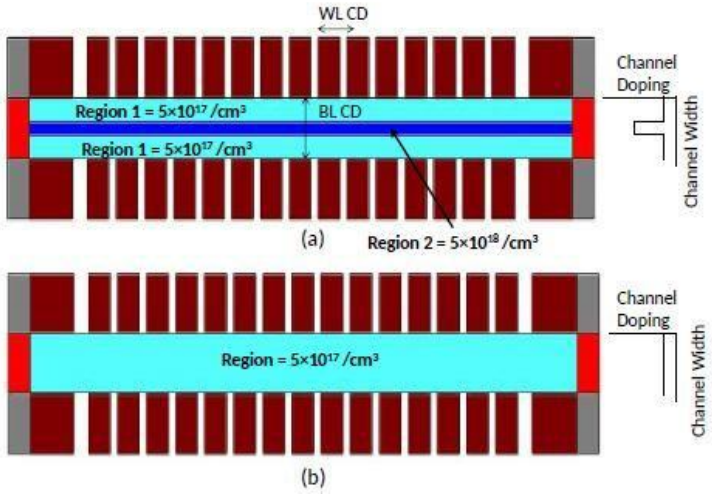

Fig. 1(a) Retrograde Channel Doping (b) Uniform Channel doping in 3D junction-free NAND flash memory

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