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(54) **MIS CAPACITOR**

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(58) **Field of Classification Search** 257/295–300, 257/303, 306–311

See application file for complete search history.

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(57) **ABSTRACT**

An MIS capacitor with low leakage and high capacitance is disclosed. A layer of hemispherical grained polysilicon (HSG) is formed as a lower electrode. Prior to the dielectric formation, the hemispherical grained polysilicon layer may be optionally subjected to a nitridization or anneal process. A dielectric layer of aluminum oxide (Al_2O_3), or a composite stack of interleaved layers of aluminum oxide and other metal oxide dielectric materials, is fabricated over the hemispherical grained polysilicon layer and after the optional nitridization or anneal process. The dielectric layer of aluminum oxide (Al_2O_3) or the aluminum oxide composite stack may be optionally subjected to a post-deposition treatment to further increase the capacitance and decrease the leakage current. A metal nitride upper electrode is formed over the dielectric layer or the composite stack by a deposition technique or by atomic layer deposition.

60 Claims, 12 Drawing Sheets