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TSAI(10) **Pub. No.: US 2023/0403847 A1**(43) **Pub. Date: Dec. 14, 2023**(54) **SEMICONDUCTOR DEVICE WITH
CONDUCTIVE CAP LAYER OVER
CONDUCTIVE PLUG AND METHOD FOR
PREPARING THE SAME**(52) **U.S. Cl.**CPC *H10B 12/485* (2023.02); *H10B 12/30*
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ABSTRACT(72) Inventor: **HUNG-CHI TSAI**, NEW TAIPEI
CITY (TW)(21) Appl. No.: **18/234,029**(22) Filed: **Aug. 15, 2023****Related U.S. Application Data**(60) Continuation-in-part of application No. 17/245,727,
filed on Apr. 30, 2021, now Pat. No. 11,778,812,
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The present disclosure relates to a semiconductor device including a semiconductor substrate, word lines, mask layers, spacers, a conductive plug, a conductive cap layer, and a dielectric layer. The word lines are disposed over the semiconductor substrate. The mask layers are disposed over the plurality of word line, respectively. The spacers are disposed over opposite sidewalls of the word lines and opposite sidewalls of the mask layers, respectively. The conductive plug is disposed between the word lines. The conductive cap layer is disposed over the conductive plug. The dielectric layer is disposed over the word lines and the spacers. Each of the spacers includes an inner spacer, an outer spacer, and an air gap. The inner spacer is in contact with the respective word line and the respective mask layer. The air gap is disposed between the inner spacer and the outer spacer.

