[0009] Co-owned U.S. Patent Application Serial No. 11/374,238 to Chen *et al.* describes novel polishing compositions having a pH of 1 to 6 including an abrasive in combination with certain acidic components (e.g., combinations of malonic acid and an aminocarboxylic acid; stannate salts; uric acid; phenylacetic acid; or combinations of malonic acid, an aminocarboxylic acid, and sulfate) to polish silicon nitride substrates.

[0010] Co-owned U.S. Patent Application Serial No. 11/448,205 to Dysard *et al.* describes novel polishing compositions having an acidic pH and including at least one additive having a pKa in the range of 1 to 4.5 to polish silicon nitride substrates.

[0011] As the technology for integrated circuit devices advances, traditional materials are being used in new and different ways to achieve the level of performance needed for advanced integrated circuits. In particular, silicon nitride, silicon oxide, and polysilicon are being used in various combinations to achieved new and ever more complex device configurations. In general, the structural complexity and performance characteristics vary across different applications. In some cases, conditions suitable for effective removal of one component of a substrate, such as silicon nitride, can undesirably lead to over-removal of another component, such as polysilicon.

[0012] Accordingly, there is a continuing need for CMP compositions and methods to achieve acceptable removal rates of silicon nitride, silicon oxide or tungsten for many IC device applications, while suppressing polysilicon removal. The present invention provides such improved polishing methods and compositions. These and other advantages of the invention, as well as additional inventive features, will be apparent from the description of the invention provided herein.

~~BRIEF~~ SUMMARY ~~OF THE INVENTION~~

[0013] The present ~~invention~~disclosure provides CMP compositions useful for selectively polishing a semiconductor substrate to remove a component such as a silicon nitride, silicon oxide or tungsten from the surface of the substrate while suppressing polysilicon removal. A CMP composition of the ~~invention~~disclosure comprises abrasive particles suspended in an acidic aqueous carrier containing a surfactant comprising an alkyne diol and/or an alkyne diol ethoxylate (preferably an alkyne diol). In a preferred embodiment, the~~a~~ CMP composition ~~of the invention~~ comprises 0.01 to 15 percent by weight abrasive particles suspended in an acidic aqueous

carrier containing 10 to 10,000 ppm of the surfactant. In some preferred embodiments, the abrasive particles comprise colloidal silica. Preferably, the acidic aqueous carrier has a pH value of not more than 6 (e.g., 1 to 4, or 2 to 3). The surfactant preferably is present in an amount in the range of 20 to 1,000 ppm. If desired, the compositions of the ~~invention~~disclosure can include other additive materials such as a carboxylic acid material (e.g., malonic acid and/or glycine) and/or an organic or inorganic salt (e.g., potassium sulfate). For example, the composition can comprise 10 to 100,000 ppm (0.001 to 10 percent by weight) of at least one carboxylic acid material. The CMP compositions can also include other common additive materials utilized in CMP compositions, such as biocides, viscosity modifiers, corrosion inhibitors, chelating agents, organic polymers, other surfactants, oxidizing agents, electron transfer agents, and the like, many examples of which are well known in the CMP art.

[0014] In another embodiment~~aspect~~, the present ~~invention~~disclosure provides a method for polishing a substrate to remove a component such as silicon nitride, silicon oxide or tungsten in preference to polysilicon. The method comprises abrading a surface of the substrate with a CMP composition of the present ~~invention~~disclosure, preferably in the presence of hydrogen peroxide. The abrading can be accomplished, for example, by contacting a surface of the substrate with a polishing pad and the CMP composition, and causing relative motion between the polishing pad and the substrate while maintaining a portion of the CMP composition in contact with the surface between the pad and the substrate for a time period sufficient to abrade silicon nitride from the surface.

[0015] The disclosed CMP compositions ~~of the present invention~~ provide effective removal rates of silicon nitride, silicon oxide or tungsten while unexpectedly suppressing polysilicon removal in comparison to the results obtained with substantially the same formulation in the absence of the alkyne diol or alkyne diol ethoxylate surfactant.

[0015a] In one aspect, there is provided a method of polishing a semiconductor substrate to remove silicon nitride in preference to polysilicon from the surface of the substrate; the method comprising abrading a surface of a silicon nitride- and polysilicon-containing substrate with a CMP composition comprising 0.01 to 15 percent by weight abrasive particles suspended in an aqueous carrier containing 10 to 10,000 ppm of a surfactant comprising an alkyne-diol, an alkyne diol ethoxylate, or a combination thereof, the composition further comprises an additive comprising potassium sulfate wherein the aqueous carrier has a pH in the range of about 1 to about 4.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 illustrates the structures of two alkyne diol surfactants useful in the compositions and methods of the present invention along with the structure of a comparative alkyne monoalcohol surfactant.

[0017] FIG. 2 shows a plot of polysilicon removal versus surfactant concentration obtained by polishing polysilicon blanket wafers with compositions of the present invention.