[0004] Patterning problems may also be caused by rough films. Some traditional atomic layer deposition (ALD), chemical vapor deposition (CVD), high-density plasma chemical vapor deposition (HDP-CVD) and plasma-enhanced chemical vapor deposition (PECVD) processes for depositing film layers may produce unacceptably rough films, cause unacceptable interfacial mixing between film layers, and may have interfacial defects caused by vacuum breaks between successively deposited film layers. The resulting rough film interfaces and interfacial defects may be magnified by subsequently deposited layers as the film stack is built, so that the top surface of the film stack may be unacceptably rough for downstream patterning processes. Further, interfacial defects within the film stack may lead to structural and/or electrical defects in the resulting integrated device.

SUMMARY

[0005] Various embodiments are described herein related to depositing film stacks in a process tool in-situ (i.e., without a vacuum break or air exposure) using plasma-enhanced chemical vapor deposition (PECVD). ~~In one example, a method for depositing, on a substrate, a film stack including films of different compositions in-situ in a process station using a plasma is described. The method includes, in a first plasma-activated film deposition phase, depositing a first layer of film having a first film composition on the substrate; in a second plasma-activated deposition phase, depositing a second layer of film having a second film composition on the first layer of film; and sustaining the plasma while transitioning a composition of the plasma from a first plasma composition of the first plasma-activated film deposition phase to a second plasma composition of the second plasma-activated film deposition phase.~~

One specific expression of the invention is a method for depositing, on a substrate, a film stack including films of different compositions in-situ in a process station using a plasma, the method comprising:

in a first plasma-activated film deposition phase, depositing a first layer of film having a first film composition on the substrate;

in a second plasma-activated deposition phase, depositing a second layer of film having a second film composition on the first layer of film; and

sustaining the plasma while transitioning a composition of the plasma from a first plasma composition of the first plasma-activated film deposition phase to a second plasma composition of the second plasma-activated film deposition phase, wherein the first and second plasma compositions are formed using different reactant gases.

Another specific expression of the invention is a plasma-enhanced chemical vapor deposition apparatus configured to deposit a plurality of film layers on a substrate without exposing the substrate to a vacuum break between film deposition phases, the apparatus comprising:

a process station;

a reactant feed fluidly coupled to the process station, the reactant feed configured to supply a particular reactant gas mixture to the process station during a particular film deposition phase;

a plasma source configured to supply a plasma to the process station; and

a controller configured to control the plasma source to:

generate reactant radicals using the particular reactant gas mixture during the particular deposition phase, and

sustain the plasma during a transition from the particular reactant gas mixture supplied during the particular deposition phase to a different reactant gas mixture supplied during a different deposition phase.

[0006] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.