METHODS OF CONTINUOUSLY WET ETCHING A PATTERNED SUBSTRATE

FIELD

[0001] The present disclosure relates to methods for continuously processing substrates having reactable surface compositions and, more particularly, to continuously wet etching metalized, patterned substrates.

SUMMARY

[0002] ~~In a first aspect, a~~A method for patterning a substrate is provided. The method may include providing a substrate comprising a metalized surface having an etch resist patterned region and an unpatterned region and passing the substrate through a reaction vessel. The reaction vessel may include an etchant bath including an oxidizing agent and a metal complexing agent. The method may further include wet etching the substrate within the reaction vessel by contacting the metalized surface with the oxidizing and metal complexing agents to remove metal from the unpatterned region, maintaining the concentrations of the oxidizing and metal complexing agents in the etchant bath by delivering a replenishment feed of each of the oxidizing and metal complexing agents to the etchant bath at a first replenishment feed rate and a second replenishment feed rate, respectively, and maintaining the concentration of the metal in the etchant bath by discharging an amount of the etchant bath from the reaction vessel at an etchant bath removal rate. The first and second replenishment feed rates and the etchant bath removal rate may be determined based at least in part on a rate that metal etched from the substrate enters the etchant bath.

[0003a] In a first aspect, there is provided a method of patterning a substrate comprising: providing a substrate comprising a continuous web having a metalized surface having an etch resist patterned region and an unpatterned region; passing the substrate web through a reaction vessel, wherein the reaction vessel comprises: an etchant bath comprising an oxidizing agent and a metal complexing agent; wet etching the substrate within the reaction vessel by contacting the metalized surface with the oxidizing and metal complexing agents to remove metal from the unpatterned region; after wet etching the substrate: (i) rinsing the wet etched substrate with a first rinse of water; (ii) collecting the rinse; (iii) recycling at least a portion of the collected rinse to the etchant bath; maintaining the concentrations of the oxidizing and metal complexing agents in the etchant bath by delivering a replenishment feed of each of the oxidizing and metal complexing agents to the etchant bath at a first replenishment feed rate and a second replenishment feed rate, respectively; and maintaining the concentration of the metal in the etchant bath by discharging an amount of the etchant

bath from the reaction vessel at an etchant bath removal rate; wherein the first and second replenishment feed rates and the etchant bath removal rate are determined based at least in part on a rate that metal etched from the substrate enters the etchant bath.

[0003] ~~In a second aspect, a~~A method for processing a substrate is also provided. The method may include providing a substrate and passing the substrate through a reaction vessel. The substrate may include a reactable surface composition and the reaction bath may include a first reaction agent and a second reaction agent. The method may further include contacting the reactable surface composition with the first and second reaction agents to carry out a reaction therebetween and maintaining the concentrations of the first and second reaction agents in the reaction bath by delivering a replenishment feed of each of the first and section reaction agents to the reaction bath. The first and section reaction agents may be delivered to the reaction bath at a first replenishment feed rate and a second replenishment feed rate, respectively. The first and second replenishment feed rates may be determined based at least in part on a rate that the substrate is transported through the reaction vessel.

[0003a] In a second aspect, there is provided a method of processing a substrate comprising: providing a continuous web substrate comprising a surface composition capable of reacting and/or solubilizing in a reaction bath containing one or more reaction agents; passing the substrate through a reaction vessel, wherein the reaction vessel comprises: a reaction bath comprising a first reaction agent and a second reaction agent; contacting the surface composition with the first and second reaction agents to carry out a reaction therebetween; following contacting of the surface composition with the first and second reaction agents: (i) rinsing the substrate web; (ii) collecting the rinse; and (iii) recycling at least a portion of the collected rinse to the reaction bath; and maintaining the concentrations of the first and second reaction agents in the reaction bath by delivering a replenishment feed of each of the first and second reaction agents to the reaction bath, wherein the first and second reaction agents are delivered to the reaction bath at a first replenishment feed rate and a second replenishment feed rate, respectively; and wherein the first and second replenishment feed rates are determined based at least in part on a rate that the substrate is transported through the reaction vessel.

[0004] The above summary of the present disclosure is not intended to describe each embodiment of the present ~~invention~~disclosure. The details of one or more embodiments of the

~~invention~~ disclosure are also set forth in the description below. Other features, objects, and advantages of the invention will be apparent from the description and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The disclosure may be more completely understood in consideration of the following detailed description of various embodiments of the disclosure in connection with the accompanying figures, in which:

[0006] FIG. 1 illustrates a schematic diagram of a system for continuously processing a substrate having a reactable surface composition in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0007] Microcontact printing uses micropatterned elastomeric stamps, typically made from polydimethyl siloxane (PDMS), that are inked and placed onto a substrate to localize a chemical reaction between molecules of the ink that are able to form a self-assembled monolayer (SAM) on the substrate. The patterned SAMs resulting from such technique have served as resists for selectively etching metal and metalized substrates, to form electrically conductive patterns.

[0008] Processes for selectively etching metal patterned substrates include contacting the substrate with fluid from an etchant bath to remove the metal from the unpatterned regions. For example, International Publication WO 2010/151471 describes a method for wet etching a SAM patterned metalized substrate that includes passing the substrate through an etchant bath that is agitated with a bubbling gas. In such methods, as the primary etching reaction and any side reactions occur, the etchant species present in the etchant bath are consumed which, in turn, lowers their concentration, thereby slowing the etchant rate. Additionally, metal removed by the etching process is deposited into the etchant bath which, over time, causes the concentration of the metal in the etchant bath to build, thereby resulting in the formation of defects (e.g., precipitate films, residues) on the etched substrate. Consequently, as the concentrations of the etchant species and/or the metal in the etchant bath fall below or exceed predetermined thresholds, the etching process must be interrupted periodically to allow for replacement of the etchant bath. Therefore, methods for controlling and/or maintaining the concentrations of the etchant species and/or etched metal in the etchant bath, and thereby allowing for extended runs of continuous wet etching of a patterned, metalized substrate may be desirable. Heretofore, such methods have proven difficult at least because there exists no feasible means to track, in real time, the relative concentrations of etchant species or metal in the etchant bath.