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Tungsten CMP using Fixed Abrasive Pad with Self-Conditioning

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Key Words: chemical mechanical polishing(), fixed abrasive pad(), tungsten(), self-conditioning(가), hydrophilic polymer()

Abstract

The chemical mechanical polishing(CMP) is necessarily applied to manufacturing the dielectric layer and metal line in the semiconductor device. The conditioning of polishing pad in CMP process additionally operates for maintaining the removal rate, within wafer non-uniformity, and wafer to wafer non-uniformity. But the fixed abrasive pad(FAP) using the hydrophilic polymer with abrasive that has the swelling characteristic by water owns the self-conditioning advantage as compared with the general CMP. FAP also takes advantage of planarity, resulting from decreasing pattern selectivity and defects such as dishing due to the reduction of abrasive concentration. This paper introduces the manufacturing technique of FAP. And the tungsten CMP using FAP achieved the good conclusion in point of the removal rate, non-uniformity, surface roughness, material selectivity, micro-scratch free contemporary with the pad life-time.

1.

(lithography)

(depth of focus)

(die) (planarity)

(wafer) (global

planarization)

(chemical mechanical polishing :CMP) ULSI

가

(1)

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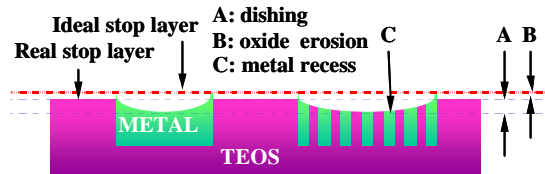


Fig. 1. Defects such as dishing, erosion, and recess during Metal CMP

CMP

(pad), (slurry)가

(topography),

(dishing), (erosion),

(recess)

가,

(Fig. 1).

가

STI(shallow trench isolation) CMP

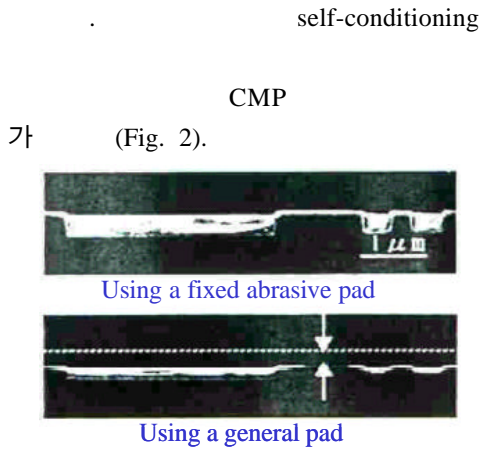


Fig. 2 Comparison defects between FAP-CMP and general CMP(source: Rohm Co.)

2.

2.1 swelling

hydroxyl group(-OH), carboxyl group(-COOH),
carbonyl group(-CO), amin group(-NH₂)
(hydrophilic radical)
(H₂O) 가

swelling (Fig. 3).

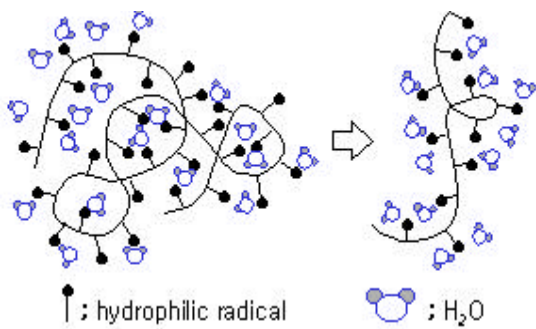


Fig. 3 Swelling phenomenon of hydrophilic polymer

2.2 self-conditioning
CMP 가

(pore) 가 (IC1400™)
(glazing)
(Fig. 4).

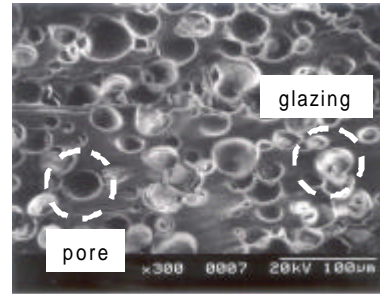


Fig. 4 SEM picture of IC1400™ pad surface after CMP

rate) (removal
(WIWNU)
(WTWNU)

Fig. 5 CMP

CMP

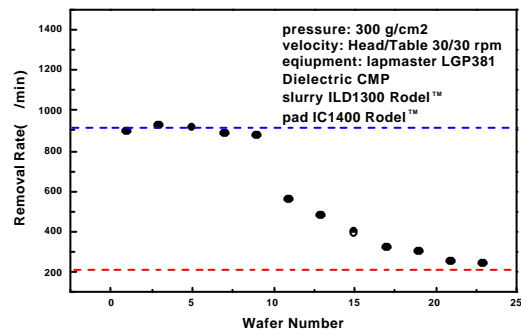


Fig. 5 decreasing removal rate for polishing wafer number

(conditioning)
CMP CMP

(carrier) 가 가 swelling
 (poly-urethane) 가 (ball mill) (initiator)
 sub-micro (planarity) (UV) IC1400™
 (2-3)
 swelling
 conditioning
 CMP self-conditioning
 SEM(scanning electron microscope)

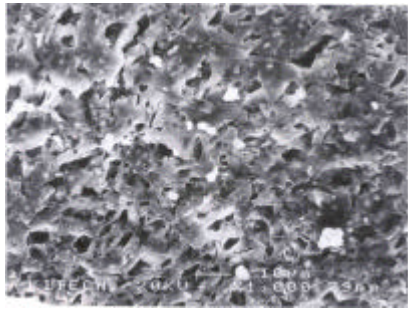


Fig. 6 Surface of fixed abrasive pad with alumina after tungsten CMP

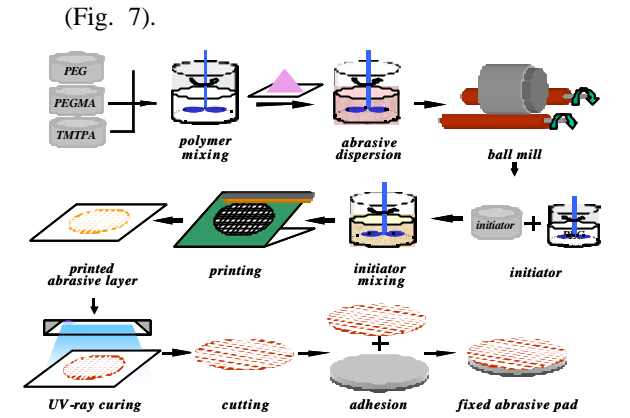


Fig. 7 Manufacturing process of fixed abrasive pad with alumina

2.3 CMP
 1.22μm(D50)
 (Al₂O₃) (binder)
 PEG(polyethylene glycol), PEGMA(polyethylene glycol monomethacrylate), TMPTA(trimethylopropane trimethacrylate) 3가
 swelling
 PEG: PEGMA:
 TMPTA= 4:5:1
 swelling
 3-functional 3 가 TMPTA 가

CMP
 3. CMP
 3.1 CMP
 CMP
 CMP
 Pourbaix (oxidizer)
 swelling
 pH 4
 CMP

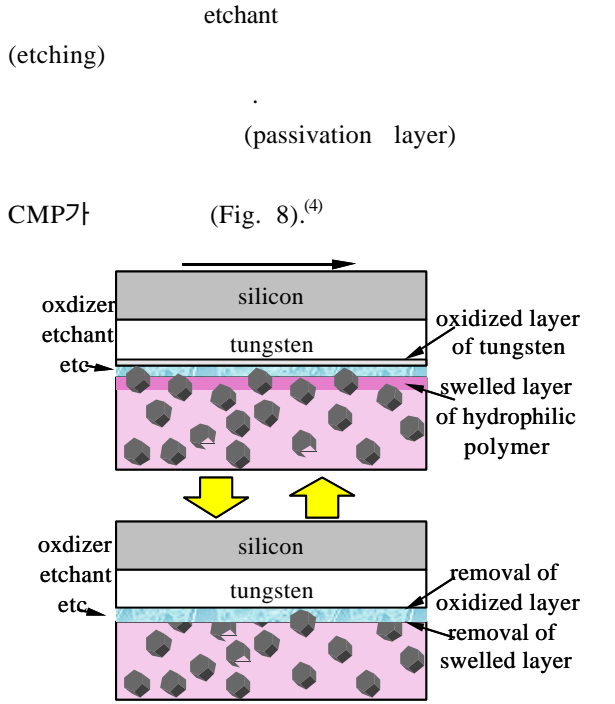


Fig. 8 Tungsten CMP mechanism using fixed abrasive pad

3.2 metal CMP (oxidizer), (acid), (inhibitor), (chelate agent) 가 가 CMP H₂O₂, Fe(NO₃)₃, KIO₃ KIO₃ Fe(NO₃)₃ H₂O₂ 가 가 H₂O₂ 가 Fig. 9 H₂O₂ 가 35wt%

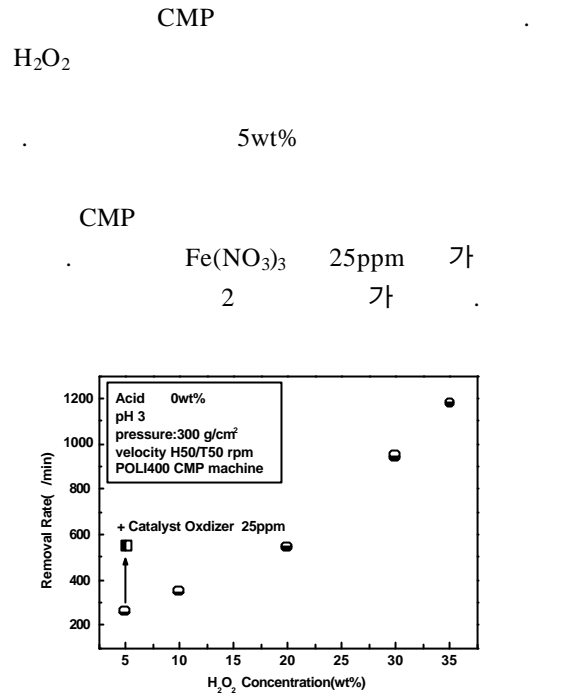


Fig. 9 Removal rate as a function of oxidizer concentration

H₂O₂ 가 가 Fe(NO₃)₃ 가 가 (Fe²⁺) (Fe³⁺)가 HNO₃, H₃PO₄ 가 가 H₃PO₄ H₂O₂ Fig. 10 H₃PO₄

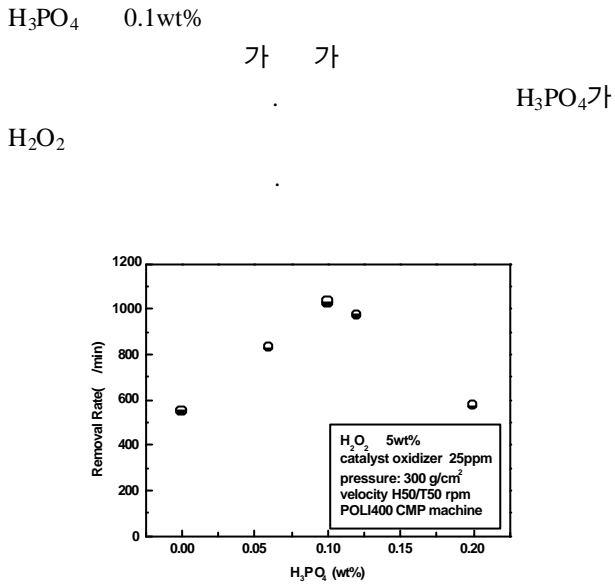


Fig. 10 Removal rate as a function of acid concentration

3.3

CMP
Preston

(Al₂O₃)

CMP
가 가

swelling

가

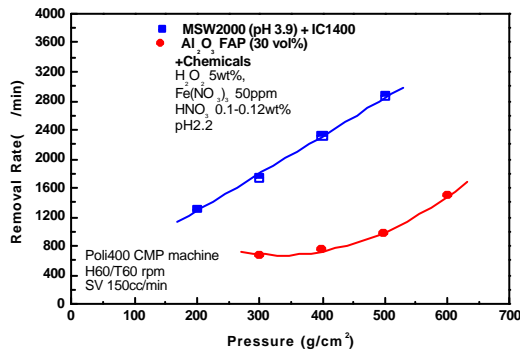


Fig. 11 Removal rate as a function of polishing pressure

Fig. 11

CMP
CMP
3.4 CMP 가
CMP
가 Table. 1
CMP

Table. 1 Experimental conditions

Parameters	Experimental conditions
pressure	500 g/cm ²
velocity(head/platen)	100/100 rpm
pad	FAP (Al ₂ O ₃ 25vol%)
flow rate of chemicals	100 cc/min
chemicals	H ₂ O ₂ 8wt%
	Fe(NO ₃) ₃ 50ppm
	NHO ₃ 0.1wt%
equipment	G&P Tech. POLI400

(barrier layer) Ti TiN
oxide Ti, TiN oxide 1999 Å/min, 5209 Å/min, 27 Å/min

Fig. 12

2.6, 1.81

, oxide 100

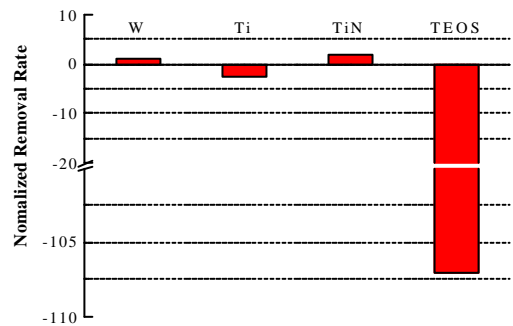


Fig. 12 Material selectivity of fixed abrasive pad for tungsten CMP

CMP
가 AFM 40 point
20 Å

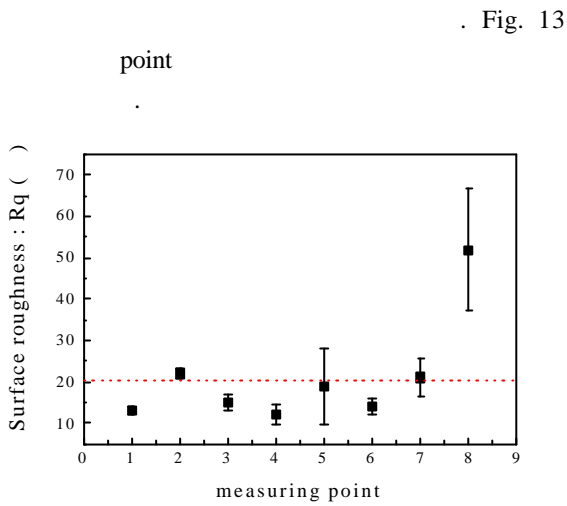


Fig. 13 Rq at measured point on polished tungsten wafer

Fig. 14

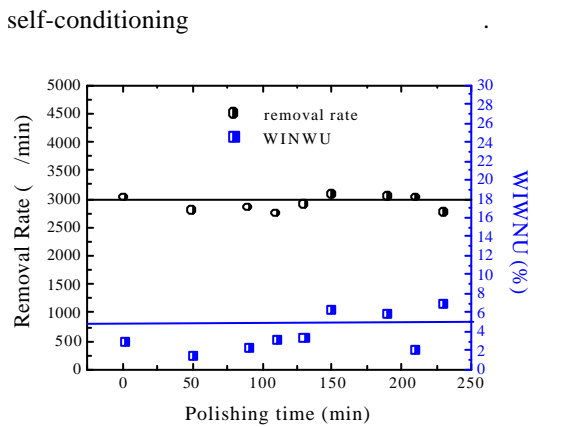
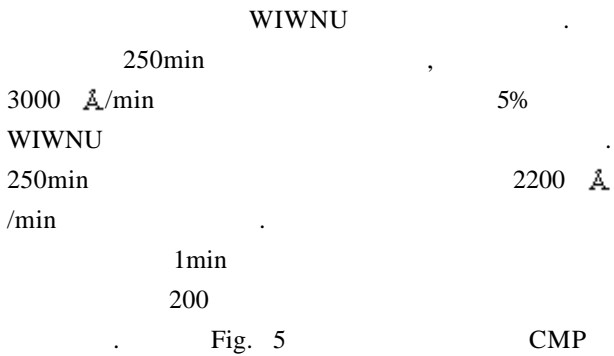


Fig. 14 Removal rate and WIWNU as a function of polishing time

4.

가 CMP 가 self-conditioning

CMP

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