¥i· ⁄Jƒ ¡MEMS •L•P·œS †Nfb⁄H⁄u⁄œfi ' ªƒX†s˜ ″°·œ⁄W ⁄S‹ ª o»P †¥ ¿(3/3)

› p e ‰,NSC92-2314-B-038-012
ı ƒ ˙ »92¡£~8 ⁄°1 ⁄ Ø 93 ƒ~7 ⁄°31 ⁄Ø

¥D «ø ⁄H¡GS ı †· › ¥ x ¥ _ ´ · ⁄ j · ⁄ f ~ ´ · |⁄f ~· _ •´ ·‹ª
› p e »P¡GH.›ß fl¤}¥ x ¥ _ ´ · ⁄ j · ⁄ f ~ ´ · |⁄f ~‹ ·‹ª¤s'
‰ † ŒS» ¥ x ¥ _ ´ · ⁄ j · ⁄ f ~ ´ · |⁄f ~· _ •´ ·‹ª

⁄@¡B⁄⁄ ″K›n

¯ ¥ ¥…„g ħı† ÐBz⁄¸ ħı† ÐBz« Æ″SiC"¿ ` ‰⁄¤^ Lƒ] ħı† ÐBz¤˘–oSiC` ‰⁄»P·Æ›

¥»× ª s¥ H »†xy@• L « ‹ « D fl } âƒ¡¥i⁄l†J¥˝` †¡G„ ″G»PSiC` ‰⁄,g•L¤ Ł"·œ « ‹ S⁄œ· ¯ Ø " ″ • Pœ⁄ƒl¥¶¡A@¤B»P , » ' ·œ–o" ″L w« ›¨ † G‹O †¯" ″Cƒ ⁄œ« · ¯ Ø † , ¸ ƒ ¤ • P · œ , „m¡A¥H†š˜A″P˝Tœ⁄£„q` ‰⁄S „c‰¢ƒXfl S°¡A«h ‹ · ¯ ØS·"^ › ' T «⁄·¸`«Æ' ª ƒ X{« ¡¶if PZT £„q` ‰‹ „ "″¯ .|.h †″c⁄ "R¡A ‹ ªs⁄⁄S Q ¥ ¸ " – K „c‹fi. ⁄˘‹ ¤t†¸ ƒA⁄ SO¶if ƒ ¶ ⁄ "R¡ €H"«†zfi ‹ ¤ £n (HDP-CVD)¤ I £″⁄˘"¿(SiC)` ¡ ‰'P«‹ (PVD)"″ ″‰ ⁄ ⁄ fl㜘"¿»PPZT £„qS fi˘ (100)"¿· „ ¶⁄¥A– ¥H• » fi‰(Sol-Gel) S @ ⁄¶¡...h¡A„gSEM˘ ƒ –o" ¡A ″‰⁄»P⁄G "k»s†˘PZT £„q` ‰⁄¡A¤^¥H¿n¯ Øq„ » s{ fiæ⁄˘"¿⁄PZT £„qS fi˘¤ªƒ †u¶V"″" fl – ´ ¶ S⁄G£"k–NPZT £„q` ‰⁄– ´¶' ⁄O¡ €HPVD`Æ "″ ″` ‰⁄,gTEM˘ ƒ –o SiC` ‰⁄⁄W €H–'£ ħı⁄¸S † th⁄⁄Łf¡„ " ¡A ″` ‰⁄‹ ƒh·„‹ ¥B‹ ¤ªS„q" †v"" PZT £„q` ‰⁄¶if ħı› Þ˘PZT £„q` ‰⁄ α(bcc)¯Ø⁄ ¥ ⁄Ł †″c¡C„g¥ |I–· w·œ–o ″ ¤ª £„qfl S°¡AƒA¥ ML..v» s{(lithography) ` ‰⁄„q" ›¨‹ ‹ø170μΩ-cm¡C• » fi‰Yk»s ⁄¸` | "k(lift-off)»sS @ ¥ e«„q•‹¥¡AS„ƒ¤ †˘PZT £„q` ‰⁄,g– ´ ¶ S⁄A¥H ħı⁄Łf¡ " ″ ⁄¥⁄ SO¥H» „¶if ` ‰⁄⁄ ¸ ⁄¥fl S°⁄ ¶if «Æ† Ðz¡ ŒHX-¥œ"″´ ¶g⁄ "R ф{¥HS " R ← QCfb £„ q • L «•P„„œq'¯– ·Q⁄¸ ß † t h⁄«Æ″ £„q` ‰⁄¤ªƒ†PZT‹ ¡A¥Bƒb ƒ ⁄W¡A« hO¥ ″q" ¯ ⁄ ˘⁄¸″|„q‹y·œ„ ‹ PZT £„q` ‰⁄"″»k¤Ł» s{⁄⁄ ф{¡Afbfl´Cl2 ¥D¡C„g« ªs † " G ª¡¥SiC` ‰⁄,g⁄@ p fi·Æ fi ¯Ø⁄ƒ†† ¤¸"″»k¤Łfi˜†v¥B¤ª¥› ª″»k¤Ł fi ħı« ŒHAFM˘ [ „ o ƒ"'œ¯–ƒ† ¡Cƒ „gTEM˘ ƒ ¯ ¥ ¡ ŒHPVD⁄Łf¡`Æ ·„ ¥ Ðs ƒb ƒ† flS 'w "″ £⁄Ł ƒV "″» „q•¥»P £„qS fi˘` ‰⁄¸ ″` ‰⁄‹ ›–'… (preferred-orientation)¡GIXRD¯ ª ¥,g ħı ƒ„¤^ L´ X††{¶H¡A¥ ƒ„–o" ″` ‰⁄fl ƒ†fi˜ «ÆSiC` ‰⁄¤ª(110) £⁄ŁƒV¡C›Ł¤ £n"′SiC " » ` ‰⁄,g400°C"″ƒ^‹ y» s{⁄⁄»P £„q ` ¡ ‰'•L¤ Ł"·œ, » ¶if •L w« ·œ, ¡A¤ S fi˘` ‰⁄⁄⁄ g "˜»P» "″¥ ⁄‹´ X†¡C £„q •L w« › ¿œ« 50 GPa¡C,g` ‰⁄ † Ø¶qœ» • L « •P·œ„ g•¥˘¶q-„q† ı ƒ‰Ù″¶q·œ–o ·œ–o SiC ` ‰⁄"″ *O ›¨‹ £ *O " ¤ Pr›¨ƒbl1.9 ~ 18.78 μC/cm²¡A¥ ƒ„–o" (compressive stress)¡A¥B *O›¨ ¥p« "″…W £„q` ‰⁄»s ƒ ¤ " ″ P·œª⁄¸¥„q‰¢ƒXfi˜ ¥ [ƒ …W¥C„g¥ ESCA¶if ` † ⁄"Ro †¡C " ¡A¥…„g ħı† Ðz⁄¸ ħı† Ðz« Æ″SiC` ‰⁄ ^ ` ¡G⁄œ« · ¯ Ø ¡ A ^ › ' T «¡A» ' ªƒX¡A ⁄S` †fl ¶q¤^ L ¥ƒ⁄˘ ¨ † † †£¡¥A´ fi"k¡A £„q` ‰⁄¡ A • L «•P„œ

Abstract

In this study, we designed and also implemented: the integration processes of an integrated circuit for a microsensor, which can be used in monitoring the initial stability of dental implants and the process of osseointegration of bone-implant interfaces. The substrates used in these experiments were p-type (100)-oriented Si wafers with a resistivity of 5-10 Ω-cm. The Si wafers were prepared through an RCA clean process. After undergoing RCA cleaning, silicon carbide was prepared using a high-density plasma chemical vapor deposition (HDP-CVD) system. A PZT thin film was prepared by the Sol-Gel method, and this method was also used for microsensor fabrication. The interdigital electrodes were fabricated by a lift-off process. Properties of the device and thin film were evaluated by physical analyses. Resistance was varied and measured with an HP4145B semiconductor parameter-analyzer to investigate the electrical properties of the microsensor. In material preparation of the PZT thin film, we had to select the best process for our experiment. The Sol-Gel process was determined to be the best for our experiment, because it is easy to control the composition and there are fewer impurities in solution. In addition, it is a low-temperature process, so this can decrease the diffusion phenomenon seen at high temperatures. Furthermore, the properties of the precursors can be varied by adjusting the viscosity and solvent contents, and various electrical properties were created. Based on the above description, the Sol-Gel process was selected for our experiment. According to our investigation by analyses, SiC film possesses high hardness and the preferred orientation after post-annealing. Based on GIXRD analyses, the annealed SiC film possesses the (110) preferred orientation. The (110) preferred-orientation is helpful for surface wave transmission. Compressive stress exists in the as-deposited SiC film. As the thickness increases, the compressive stress obviously increases. The interstitial carbon trapped in silicon lattice sites causes the increase in stress. According to ESCA analyses, the binding energy does not shift before and after annealing. This reveals that SiC films do not react with nitrogen gas in the annealing ambient conditions. The multilayer structure of PZT/Ta/SiO_2/Si was investigated, and its electromechanical characteristics analyzed. Ta film possesses better adhesion between SiO_2 and the PZT film. In addition, Ta film has an α(bcc) structure, which has low resistivity. In the dry etching process, pure chlorine gas possesses a better etching rate on PZT film. The smooth sidewall of PZT film produced by etching with Cl gas was obvious by SEM observation. In the copper electrode fabrication, the 400 °C reflow process after Ta and Cu deposition was performed to reduce microvoids. The interdiffusion phenomenon of Cu and Ti atoms from the PZT film was not observed with TEM analyses. This reveals that the Ta film is a good barrier against Cu and Ti diffusion. In P-E curve measurements, Pr values for PZT layer were in the range 11.9~28.78 μC/cm^2. This reveals that the microsensor possesses electromechanical properties.

Key words: dental implant, stability,

osseointegration, Sol-Gel method, PZT piezoelectric thin film, microsensor.

⁄G¡B›p e‰t¥ »P¥ ""

ƒ b ⁄ f ~ ´ · ` { Š ¶ É_⁄W¡AŠt¸{⁄Ć„¥-fi¦Å¥Ł"c""^ ‹ ""‹ p]• |... v T¤f ⁄ @ fi M ƒ † fi ~ , ¸ , m ¥ i ¥ H ¤ ŠU ßƒ ⁄Me‹Wv›¨¡ØƒA¥⁄dWf M Wv¤ªf ¶q⁄ ˇ ⁄"R « Æ ⁄ ¸ ƒ b ´ ¡ ƒ X „ L { ⁄ ⁄ ¡ A'‰ŁƒA¥"flS'¸°¡Z‰ŁƒÆ„¥"¥ę~¤ £ ⁄ F ⁄ ª~Š"fi¸·œ „ ·¨ØP¤ · ⁄ J † ¡ ƒ ‹ ⁄ ¶¡'T«œ¥"‹¡Z¥A⁄S.‡vQ ... Šx¥ƒæfb¥´"«´ ·¨"» ¯ ŢC¥ « e ` { Š ⁄ W fi¥ŁX'-æfiyg‰w„†"" ƒ · ¶ ¥ K«⁄ œ‹ · ¯ Ø ¥ JDœE⁄fiŠ⁄Ł "k¡Cƒ ¥H X-ray ¸ œ⁄HØ w † ´‹· y ¥ «‹ «of ¥H⁄U""› ¤ »Pfl°´I¡C†~⁄ ¢AX-ray ...v „† L"k »·œ 30%¥H⁄U"" ' ‰' ¸ƒ‰ Ł ¥¥¢ [1] ¡Af ƒ„ L"kŠ@‹ ƒ ›`¶ É_⁄ ¤ª¡A⁄ ˇ ƒ'„ ' „ ' » ~ Ÿ ¡C¥†~⁄G¡ A ' æ fi‰„u†fVb'w ¶q⁄ W ƒ‹• ⁄ Šx¡ˆAfƒ „„ ' ‰Ł""‹ ¥¢ ¥ u fl ¥w'¡°C†[„T¡ A ' æ fi‰„u†:V¿ fi g ‰ffi†⁄H ØA‹O⁄@" «I⁄J' °¶ É_⁄ Łk¡A ⁄ £ Š Q '"¶ffi"" l ´"·œ¡C†~¥|¡AX-ray ...v„† ~ ' ¶ Q › ¤ ¡A» ø fi "¡'ØA ¤ 'æfig ‰u•‰"¤ œ – o ¥¶¥ †›¸⁄lfl ' e › ß ¦ƒfCA" » „ Š@⁄H› ß ¥»‹ ¤ „L– M • ~V‰fi⁄H ›ß¡Af ƒ„† ¶ ¸‹df ¥ • ƒh› ¤ ¡C

ƒ ¥@" ⁄ Łkƒp Periotest® † £ « ~ ©Š Q¥¸ ⁄ œ ‹ · ¯ Ø ¤ ⁄ O « Æ " " ƒ † – ¡Š ^ › ' T "¤[2]¡C ¥ƒŠ ¸⁄ @ › ‰~⁄O¥ h ‡. » ⁄ œ ‹ · ¯¤Ø¡^A»·œœ ‹ · ƒØ ... † P·Œ" „ fi ¶¡¡A• ° • ¤ ¶A⁄‡.†""fi ¶ ¦U¡A¦ ¥ Hfi„Š @ ‹ ⁄ œ · °¯Ø«" " ¤ ¡ C ƒ ¥o... ¸ ""⁄ Ł " ¥P‹C⁄ j ⁄ p ⁄ ¸ ŁƒjVAŠ¥Y ¤ ¥i¥H ¥ ›p'T' w Ę ⁄C¶q"" „æ¡Af ‹ ¥[⁄fkœ · ¯Ø⁄W""⁄ Ł ƒ V£ƒÆ· N • | – ¤ ™£ƒP " G ¡ Ć]Sfi„Q ¥⁄¶D q Ę ⁄o œ ‹ · ¯ØM¥ŒÉ´· ¥ –ƒ‹ œ ‹ · Ø"(displacement)¡ A Š P⁄ œ ‹ · Ø"‹ˆ¡›ATŠ @ ‹ ‹d⁄œ‹ ¯Ø^ ‹ "‹™A Łk¡A` M‹O¥ « e ¥–™¤£ ⁄ Łk¡Af «of ¥£¤ ‹ Š¥ŁC

ƒ M Wv(natural frequency)‹ " « ‰›Ł ' °(stiffness)»P‰Ł¶q(–K«)"¤ ...ˇ¡Af ƒ„⁄S " ‹ " ‰Ł"" °"A ...ˇ(dynamic parameter) [3,4]¡ Ć"«† z N,⁄qW¡A¥ffl " † ¥XŠ¥"fiˇ o¥ ˝ ¯⁄fi ¡A¤ › Ł°«Y..ˇ»P–K« ¯ ⁄ˇ" "¡ , ¡CŠ Ę¿fi¶ °† ‰ Š @ ⁄ f ~ ´ ·¥"ª¤us ¤ª¡A⁄j†⁄¥ ¥H⁄ ‹ ¤ ⁄j ¥¥¿ ŁV¡G⁄@‹ ⁄œ ' ‰⁄" ¢A"– ·Q¡A⁄@‹ ⁄ œ ‹ ·»P¯Ø‹ ' † ´ · "D » œ¡Noyes ⁄¸Solt ‹O› ¥ ŠQ ¥¿fi¶ °† z ‰ –·ƒ Q M¥ ¿ ⁄ ⁄` ƒ ª«"" · " [5]¡COka ¥HŠ Ę¿ ƒP""› †z ofii⁄@fiM¥] ¥ˇ¡ Æ¿¥ H »·œe'P¶ ª a" ¢A»P⁄œ ƒ"" •n « [6,7]¡COkazaki ¥H«hŠ Ę¿ƒ„† ‰ ⁄ æß⁄ "Rƒ M⁄œ'P¶ ª a»Pƒ Ú ⁄H⁄u⁄œ'P¶ ª a"¶fi¶ °flS'°[8]¡C Lee ¥H"‹ ªs‹O›"ƒ,Š Ę¿ƒ M Wv‹ ...ˇ¡ ÆØ¥ ~ ª ƒQ M⁄œ'P† † ´ · "« o¥ ˝ ¯⁄fi ƒ M Wv›¨""¯ ⁄ˇ¡ Ć‹ † o ‹ ªs⁄¡A o† { † ´"‹ ""¯ ⁄ˇ»Pƒ M W ¥⁄¶Š¡· X ĘŠ‡e{‰u' °""^ «Y¡A¤^^ 'œ Š Ę¿ƒ M WvŠ @ »œ⁄œ ƒ'P† ' "‹ "" u¶V' °[9]¡C –Ni¶ °† z ‰ ¥¿ƒb⁄ œ ‹ · ¯Ø"" ⁄ œ ‹ · ¯ Ø ¤ ⁄ O « Æ " " ƒ † – ¡Š ¿¡Æ¤«kŠ@Q"æ·Xƒ‹d"¤¡C Kanoko Š Ę¿fl ‰˜†£ ¥˝ „ Ę ⁄o œ ‹ · ¯ØŸ"¶ T (harmonic response)"iŠ⁄ R -· ¯Ø(bone-implant) ‹ › – P †"" ^D[10-14]¡C ƒ ¤ ª¤sjf h ‡k› › ' fi „ˇŠ "¿"– ·Q¡A„ 'ffĆ¶ Wv¤^¥ ... ¥¡C Meredith ¥H«h¶i⁄@¤BŠ Ę¿¥¿'¶"i¿E o⁄ œ ‹ · ¯Ø«ÆE¤ ""ƒ@fi¶ Wv› ¨ ⁄ "R"R '–· ¯Ø ^D¡A¥L o†{ƒ@fi¶ Wv'M'T« ø{« ƒ†« ⁄j""^ «Y[15]¡C– ¥L¤^Š Q ¥¯Ø " Ć¯ ¥ ¥H¯ ^ [16,17]¡C

· ƒb„ Ć⁄ Ł R⁄¡WAƒ M Wv‹ O Ę¥¸ fl ‰˜†£¥˝ „' ¿¥ ¿¥¿'¶"i¤ ¿ E o '†c"«""fi¶ °flS'°(¿ fi¶"k, harmonic response method)¡A' ¸Š Ę¿‰ ˜»"l⁄@ƒ,¿ Eo' ƒ†"" W

†v(‰ ~ »"‚kimpulse response method)¡ A ÆSQ „q ¤ t †¡]Micro-Electro-Mechanical ¥ ¸ S † t † ¥ „(Fast · «Fourier System, MEMS¡" " ª¤»»P cfii¥ 'œ¯ªf aW Transform)¡A› p " ffi¶vjWC W »S Œ¿fi¶ ¥[¡A• L „q‹‚¥ " "cfii–N• |ƒ ¤ ¥..¤ ª¤s ° † z ‰ ‹ ª ¤ s ‹ œ ‹ · S Œ"¿‹fi¶¤sS¡‹"C¥ Dy¡Af ¤ ‹Hˆ ¥"‹ ¡‹' ‹£¥ 1 ¿fl°" "@ "k¡ C M ƒ¿"k¡¶ ‹ @ ¶ O fi ¥Bt‚W" ¿fi˜ ‹ j ¶¥¡G ¤ ·¥HMEMS S †N' ¥ †£""• Ł, "k¡A' „ ' „ ¥ † ¶ • S ¯ ¿E†v«"iSfi‚f"‚ W¥ ¥ ¡A• L «•Ðe „¡]microsensor¡^‹ ¸ Ł«‹ ‹ ~ fl S „ ƒ ¤ ‹ @ › · œ , ¡ C æƒ~¤ »P]‹° „¡q‚microactuator¡^ ¥[24-26]¡Afb¥"´ ¡B " " o„F A Œ¥‰ ˜»" l ‹ @ ƒ , ¿ E¤†'v"ƒ† W fl Ł ¡B¤ ¶fi¡B ‹u‹ ¿fi¶¶O' °„q‹ l†£«~ ¥‹Ł ‰ ˜ »"k w , g ¤ œ ¥ N ‹ FW"k„[4]"¡C fi¶ ›–ƒ fi† †¥ ¸¡C¥ ' ‹‹œŁ›–""‹j·T« `Y‹p Okazaki ¥H« O›"ƒ,S Œ¿‰ ˜ »"k ª ¤‹œƒ »P»s {B† , ¸' M S@‹ W"› »¤ ¡Afb•P·œ „ fi ¶°fl S°""‹H¡A¥ Ł S Œ¿‰ ˜ »"k E o‹œ »P›P ° „‹Ł›–¡A» ›n–˜¥ ¸£ƒP' ¶·†¸""¯X ƒ¡A¤ ¥ ' – ¤ " "W†v¯ T†(frequency ‹Łƒ¡‹ ˇƒ ¶} o•s" " ‡‰« [" c¡C• L „q¤t response)„ˇS¸‹ "R‹œ' P ¶ · – ‚fib‹OW"¤‹ †¸fb‹uS@fi ¡A›"¥ ‹ O›n•P" Œ¶ D" „ ‹¸ ƒ ¡A¤ˆ´ · ƒ „ß›fH‹ ¤œ' P ¶ · – a ‰‹"F" ˜‹"¤ ¯ ‹ˇ¡A Mk«Æ¡A–N „ "'fl S°' ¸¤ ¯ ‹ˇ"" " †{¡AS@« †]›p‹H‹uS fiˇ""› « › ¤ ...[8]†C ‹j‹p¡A¶ · e „–‹¤ (•L†B†z „' „ ¤£) Elias ¥H«h« O›"ƒ S Œ¿‰ ˜ »"k ‹ "R '– †B†z¡A¤ˆfi †B† ‰" "G¡A¥ ›P ° „¤ o · ¯Ø« ›–"" ·" [18]¡C M¡Af MW†v¶q·œ ¥"‹@¤· °S@¡C• L „q¤ t¸ „ ""•P·œ „·N« "k‹ S fl´¡IAfb' ¶q¤œƒ MW†v""„ L {‹¡A • ' ‹H""†·¡Bƒ ¡B» ¡Bƒ ¡B¥ ‰S ¥‹ ›x¡C fi ¶°, „m¥†¥ SCfi ¶ ° W‹@¤B‹@¤ B – ‰yƒ ¥ ' • L „q¤ t¸""‹ ¤¥» »N« ‹p¡A' "fi ¶ ° W ¡Afbfi ¶¡‹W¤ˆ‹ £ †ƒXg fi˜ ¥H¡A•P·œ „¥»¤ »""‹ ‹o‹]›n¤D« ‹p¡C¥ ¥~¡A †¡C¥ ¥~¡Afi ¥ »Œ"æ·«' ‹ S ˆ †z„L• Łp‹˜¡A £‹F«Of†¥ ƒ ¤ ""•P" fl S° « ª s¯ ¥ ¡A‹œfi · ¯Ø‹ S MW†v• | ¥ ‰Ł ¥H¥~¡AS ƒ††\fh u´I¡Afp‹˜ †S ¡B‹uS@ W ¶ qBS ‰ Ł ¡ B ‹‹o'¡B¡ ƒ X S {¥ƒ]fl ‹S –a¥[...e¡B"¯¶¡, "R« "‹ ¸SCf¤¥» ¥¡Af ¥B ¯ ‹˜ƒ S¯¡A† o ¤…¬VTƒ MW†v¯ ‹ ˜Sƒ] S ' ·…‹…¸q Œ]ƒ„¡A• L «•Ðe „‹O¥..¤ •P fl »P‹œfi · ¯Ø^ › ' T « ‹S¦°‹ẁ† ~ †Q, ·œ „"'¥ Dy[27-30]¡C † ← Q[19-23]¡AfpHuang ¥H" "Ø¥~« ª s † ¥ ' ƒb•P·œ› † zW¡A• L «•Ðe „‹j†£ "G o†{¡ A Œ¥.¸"A· œ , "‰" ~ »"k E œ«‹ S Œ¿¶·† ¸ ƒ•Ðe „‹ ƒP‹Sƒ U ""¦kz/‹˜ · · ¯ Ø@«fi¶¥ H « D – ~ ƒ¡S¦@«S J»•œ T •P·œ› †z¡A¥ufb‹ ‹o‹W¥ [¥H` Y‹pƒ ¡fib ,„" "Łƒ¡¡A¥ ¥Hƒ fi˜ »·œ¤ ‹ œ « · ƒØM •P·œ „• Łp‹˜""„ L {‹'‹ S Œ¿""ƒ Ù »s S@ W†v›¨¡A¤ˆfb‹£ƒ P « ‰ " « ¶‹ ¸'´ ƒX ‹Łƒ¡¡Af † « ƒh¥ Cf¤.. ¡B¥i‹j¶q»s S@¥B• L « fi ƒ«ƒn""˜ F « ¡A¥B‹£‰ Ø¯Ø"„Œ ‹p‹S¿n¯ Øq, »s {S †N›l¥"ƒ ¤ [31-33]¡C ¯ ¡B¯Ø¥ ~ Œ¯' ¸ƒ†› ›,fl … ‹ "R"" "G ƒ b Sfi‹W¡A«h‹j† ¥ ¥H"¿‰ŁS fi˜« ¥D¡ Œ] S¡" †{¥Xf„‹Ł"k"" ¶V' °¡ C Mf ¡ L"k ƒ ¡A• ŁP·œ „‹j† ¥ « " ¿ S •P·œ „ » ¯S' ‹ f˜¥ B ¥¶• L p«‹ˇ""¤ ¶ ¥q‚fo¤ (silicon sensors)¡Cfb" ¿ "O‹W "'"¥t‹ @ « · ¯Ø S fi¶° T , †£›¥P‹ ƒ‹""•P·œ, „m fn†B« O¡A¥i–N„q, ‹] fbfP‹@· „ø‹WSY¿n †]›p¡A¤ · ‹‹·L‹H· £¸¡C ¯Ø‹(integration)¡ C Mf¡A„ « fh" ^ ""•P ·œ „ƒ ¤¥¡A" ¿ S ¥»¤ ›¤^‹£‹ O† ¤¸""S ƒ H « S ""‹ Øq cfii¡A‹H^ " " ª¤s fi˜¡Af]ƒ„¡A¥i• ft¤ ¥ƒ¥\fl ' °S fi˜ƒ ƒb ˜†¤‹‹ wg¶V¤ ¶ V ˜ƒV • Łp‹˜"" "fc¡A•L

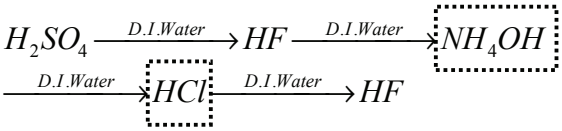
(1) [illegible]

(dipping) [illegible] (spinning) [illegible] (spray) [illegible]

[illegible]

(PVD) [illegible]

[illegible] (h_{IDT}) [illegible]



[illegible] (1) [illegible] 1.7 [illegible] -cm [illegible] 2.7 [illegible] -cm [illegible] (2) [illegible]

[illegible]

SC1

$$H_2SO_4 \xrightarrow{D.I.Water} HF \xrightarrow{D.I.Water} NH_4OH$$

$$\xrightarrow{D.I.Water} HCl \xrightarrow{D.I.Water} HF$$

SC2

SC1 [illegible]

[illegible] NH_4OH [illegible] H_2O_2 [illegible] H_2O [illegible]

[illegible]

SC2 [illegible]

[illegible] HCl [illegible] H_2O_2 [illegible] H_2O [illegible]

[illegible]

$$M + xHCl \longrightarrow MCl_x \longrightarrow M^{+x} + xCl^-$$

[illegible]

(2) [illegible]

[illegible]

» P fi æ " " ƒ ǂ -TEOS" « • » ¡A¥» ¤ › ƒ b « · ⁄ " – ` £ ⁄ U ‹ †40 Ø¡A, g¥[.acetate¡] ~ 70ºC¡A¥ H „ F ¤ ¡'M H TEOS ‹ ¥D" "SiO_2 LPCVD ⁄ ˇ ƒ¡ƒ G (TEOS) $Si(OC_2H_5)_{4(g)} \longrightarrow$ $SiO_{2(s)} + 4C_2H_{4(g)} + 2H_2O_{(g)}$

(3) " ⁄ ¸"¿` ¡‰⁄"¤H¿n

‹ · £ @"1¶ · W † v ¡ A ¥ »ª¤s S Q¥ ¸ HDPCVD¤I¿nSiC` ¡‰⁄' P«‹(100)"¿ · „ ¶ Œ ⁄ W ¡ H"¿T¥k ⁄ ˇ ǂ fi¯ØƒP fi ‹ „ q … † ¥˝ƒfA¯S Ø‹ " ⁄ ¸"¿"" « e ¯ X »¶¤H¿n¡A¥ H … W 1˝"'"¥1S¡ ƒ ¥fi(Mean Free Path)¡A¤ˇ„ q – K −o¥ H ¥S¥BS¡⁄ ƒa¶ ƒ , ´ ¡C

(4) ‰w‰˜…h(buffer layer) "ˆ ¡‰⁄"¤H¿n

‹ … W ¶ i £ „ q S fiˇ»P‰⁄G"Æ⁄ˇ"¿ " ' ° A ƒ.bƒ„¡‰G¶¡¤H¿n "ˆ ¡‰⁄ S @ ‰w‰˜…h(buffer layer)¡ A › S £„q S fiˇ t ı › Pˇ(thin layer-buffer) † " c " " † { ¶ H ¡ C ƒ " ¡‰⁄‹O¥H"ˇ (magnetron sputtering)"" ⁄ ƒ¡¡A ƒ b fi"¯ « 5¡10^{-7} Torr ⁄ U ¶ƒ10 nm «p« "¤H ¿nƒb⁄ G fi æ ˃"¡C W

(5) £„q` ¡‰⁄"¤H¿n

¥ H • » fi ƒ‰"k`Æ⁄ j • S ¥ i ⁄ƒ¤¥| › ¤B › " ¥ ¥ H …⁄decomposition¡ ^ ¥ £ ˇ ¡G❶•»† G ⁄ S ¡A❷` ¡‰⁄ƒ b S ⁄W ⁄S† Q—¡A❸ S C¯⁄S fi P… , (pyrolysis)¡ AM❹ " • ¯ ⁄ S †„»P‰o−K ⁄ ˇ¡C ❶• »G⁄S‰ »s » s S @ £ „ q ¡‰⁄Pb(Zr$_x$Ti$_{1-x}$)O_3 ⁄ S ¶ t g ˜ q · „ fi £ „ S fiˇ¡A„C¯‹O¥H 500~800 °C " • ¿N ƒ¤ , m S t ƒ ǂ ' » " Pb, Zr, Ti¡^ " " „ w ǂ•»A¤G ƒ ¤ ⁄ ⁄ S Lead acetate¡] L »„¡APb$(CH_3COO)_2$ $3H_2O$¡^ Titanium butoxide ¡]g ⁄ BJ ¡A Ti$(O(CH_2)_3CH_3)_4$ ¡^ ⁄ ¸ Zirconium acetate¡] Zr$(OH)_2(CH_3COO)_2$¡^ ƒ •» fl ǂ ¡ ¥ «h2-Methoxyethanol ¡]⁄ G ¥ ⁄A¡A$CH_3CH_2OCH_2OH$¡^¡A ¥ t ¥ ~ ¥ ‹J"A¶Formamide¡]¥ » i¡A$HCONH_2$¡^¥ H £"„@ w ǂ ˇ »†G¸"" ° ' ° ¥ H S ‰¡‰»"s S–@CB ˇJ¥ −N Zirconium acetate »P Titanium butoxide •»' 2-methoxyethanol •» fl ⁄ ‹A¤ ¥ ¸ǂ~‹ −N„ w ǂ ˇ»†G ˜¤–N„] "" ǂ⁄ •», ¡AƒA¥ ‹J Lead acetate 'T ¯Ø¡A ǂ «ÆƒA¥ ‹J Formamide ¤ S ‰` ¡ ‰ ⁄ " ›" ‹"p¤ˇ` ¡ ‰ » ¥→ª¡A¥H` SK ` ‰⁄† £ ¥ ˝ı†C", g¥[… 150 °C ¥¯ «ÆS ¥i¡C

❷` ¡ ‰ ⁄ S` Æ

S Q ¥ ¸ ¥ œ "ǂ]phEotoresist spinner¡ ^ ¤ˇ¥ ¸ −`Æ k ƒ b " O W¥H¤ Æ¥‹q ⁄ Ł¡` Æ « e › z ' t ƒ n " „w†ˇ•»†G¡C†ˇ ⁄ @ q¥1000 rpm S C ´ǂt `Æ10 ‹ ¡A ¤ ˇ „ w ǂ•S»†G⁄ ^ ⁄ SG†¡AƒG‹ ¥qH 3000 rpm "´ ǂt– `Æ25 ‹ ¥H– ¤ `¡ ‰⁄"« ¤ ¡C– `ÆS „ ƒ«ÆA– N , ø,m' ˜ ¶ ¡]furnace¡ ^S @ … ǂB¡†]z. ⁄ , ⁄ ¸ h ⁄ ǂB¡†ˆz¡A¥H¤ ⁄ ` ‰⁄† £ ¥ ˝ı†C"

❸` ¡ ‰ ⁄ ⁄ S ǂB†z

¥ H ⁄decomposition¡ ^ ¥ £ ` ‰⁄⁄⁄Sƒ ǂ ƒ¤ ¡ ÆAA¥H h ⁄ „L { ¡]annealing¡ ^ǂ B † ż¡‰⁄ǂ ⁄U⁄S L ƒ¤⁄ ¡A¥HS Q ƒ¤" ł ¥¤ª ǂ £ q'⁄S¶t g ˜ q · „ fi‹⁄⁄¡.C¤ ⁄,¥ h£· l"" ƒ ǂ ƒ¤ ¡A¤ ˇ £„q ‰⁄−o¥H› « ‰− `Æ¡A.. ¥[` ‰⁄" " « p «¡CƒH1ǂ ¥z«h ‹O¥H 500~800 °C " • ¿N ƒ¤ ⁄ ¡A¤ˇ⁄S¥˝ƒ¤¤ª ˇ £qƒ¤⁄ "˝Łp g»˜ „]· „ fi ‹ ¡CƒH1ǂ ¥z« S ¸ƒ¤⁄S £q ` ‰⁄""• ¥ ⁄ ˇ ⁄ Ł ƒ ¥ | ƒ¤' MS¤« ⁄ ŁV¡Aƒ] ƒ „ ƒ»A¥~¥ „q† ı S @ ¥⁄ˇ⁄Ł

ƒ V ‡ ‰z ¡C

❹ " • ¯ ⁄ § † „»P‰o–K⁄ˇ

⁄ w , g … ⁄ , ‡ B † z ⁄ § ¡‰⁄¡A⁄·»‹ ›ˆƒ¥A¥Hnƒ»‡˜' °"" v» ˜(HNO_3, pH<2)

" • ¯ … ‡ B † z ¡ A ¥ H « ‰ˇ` ¡‰⁄ƒ¤‹ »P ˇ B›n""fi ⁄ (NH_4OH, pH=10)¤ ^ ¡A

· „ ¯ Ø " c ‡ y ' M – o ¤ , ‰o–K⁄§•L ¥"[fbCT⁄"g ¤ ¶ƒ‹ ª i¡Aƒ » „q•¥""

• ¯ ¿ N † " " " c ¥ D n‹O a«D·„‰Ł""⁄k „"q•¥""¥ N„ƒp„ˇ⁄@' ¥ ¡C

" ¢ ¥ (viscous flow)'M› ⁄l""´ X†¿N

† ¡ C N «‡•¥¯D › ṁMƒ¤ ¤ t † ¡B › fiˇ

" ^ ¡ ‰K¥M⁄ ‡¯‡ t † ƒ‡¡ˆC ¡‰⁄

†„⁄ Ł →«ḥM § "^… ¡B‰†„z L{

⁄ ¸ §» P ` ¡ ‰⁄§…¨ « ¥ˇƒG‡ˆ

(6) PZT ¯K„q` ¡‰⁄""»k¤Ł

¥ H • » ‰"kPZT •»† G – ` Æ , ⁄ø

⁄W ¡ A , ṁJ¥H650 °C ¿ N † ⁄ @pfi ¡C

, g • L … v » s {w¡Aq„ˇƒ‡`«Æ"i

„q… »k¤Ł (ANELVA ILD-4100, Helicon Wave Plasma Etcher, Anelva Corp., Tokyo, Japan.)¶ ƒ »k¤Ł¡Cƒp„ˇ

⁄@' ¥ 44 ¡A § C £¡‰q…"– K « ¡Bƒ

° ⁄ ˇ ¡ ‰h(mũuftj-chamber)⁄§»k¤Ł

¤ ‡ ¿¡C»k¤Ł– ¥ ‹ fi g ₩\†900 W,

£¥ †v250 W, ⁄ §@ £⁄O4 mtorr,

fi ¯ Øy¶40q sccm¡C‡ «Æ¥H" › ‰ „ł

⁄ ℞»(surface analysis)¶q· œ »k¤Ł

†v⁄ ¸ ‰·ƒ¡„q⁄ Iª•LˆŁ(SEM)ˇ ƒ , g

»k¤Ł«Æ""" ›–¡C

(7) » " ˜ ‰u""„q•¥»s§@

⁄ ˇ · – æ ‹ ª ¿ i " k ¥ ¥H⁄ ‹ ⁄ ˇ · » k ¤ Ł ¤ ‡ ¡ ⁄ ¡ C –æ‹ª¿i‡¡Ł¡‹Ø fl„⁄ø¡Cƒ„¥˜¡A ⁄ F fl └q

‹ ⁄ (slurry), ¥ [⁄ ƒp(silica)' ¸T

⁄g(alummina) ¥"‹ ª i' °(abrasive)""

• L † ¡ A ¤ ^t¥"X Æ»P´ ‡ ‡A¤

¶ i ƒ ·„"⁄ª i¡ A ‹ ª ⁄⁄""‹ ª i`ß

† ⁄ ƒpfl0.1~2.0£gm ⁄ ¶¡¡Cƒ ⁄ ˇ ·

» k Ł«h‹ O¥ {J⁄ @ ¤ »˜"Þ• »Gfp† Ł æ

⁄ˇ„[(KOH)¡ Bv»˜(HNO_3) ¥¤ ¶ƒ¡C

• CMP """»s {fb¶ ƒ fi¡ A „ · ø'

‹ I¥[""£O» P ª¿ƒ¡ ""– ´ ‡t† v N•|

… v̄T¤ ‹ ª i‡t†v¡Cƒ ‹ ª i» ' ¤¥"¸"

⁄ w , g … ⁄ , ‡ B † z ⁄ § ¡‰⁄¡A⁄·»‹ ›ˆƒ¥A¥Hnƒ»‡˜' °"" v» ˜(HNO_3, pH<2)

" • ¯ … ‡ B † z ¡ A ¥ H « ‰ˇ` ¡‰⁄ƒ¤‹ »Pˇ B›n""fi ⁄ (NH_4OH, pH=10)¤ ^ ¡A

· „ ¯ Ø " c ‡ y ' M – o ¤ , ‰o–K⁄§•L ¥"[fbCT⁄"g ¤ ¶ƒ‹ ª i¡Aƒ » „q•¥""

• ¯ ¿ N † " " " c ¥ D n‹O a«D·„‰Ł""⁄k „"q•¥""¥ N„ƒp„ˇ⁄@' ¥ ¡C

" ¢ ¥ (viscous flow)'M› ⁄l""´ X†¿N ¥H•» ‰ƒ"k»s‡ˇ PZT £„q` ‰⁄•»

† ¡ C N «‡•¥¯D › ṁMƒ¤ ¤ t † ¡B › fiˇ †G, ¥g ¤ ¶ ¥ q§‡t– ¶ ""⁄ £¡–N•»

" ^ ¡ ‰K¥M⁄ ‡¯‡ t † ƒ‡¡ˆC ¡‰⁄ †G§ ‹ˆ– ¶ ' "‰ƒiæˇ"¿ † †

†„⁄ Ł →«ḥM § "^… ¡B‰†„z L{ " eW¡AƒA¥H"" 650 °C ¿N †• ¤ ¶i

⁄ ¸ §» P ` ¡ ‰⁄§…¨ « ¥ˇƒG‡ˆ ƒ "• ¿N †¥H§ ¸ ƒ ¤ ¶ g˜"q c¤^

¤ˇ¤ ª ‡¤"¸" „q´ · ‰§'°¡C »sƒ¤""

(6) PZT ¯K„q` ¡‰⁄""»k¤Ł •Ł« ‹ • P · œ „⁄•¥ "ę¡B ¯ |†"c

¥ H • » ‰"kPZT •»† G – ` Æ , ⁄ø "/" ¤z'‰Ł¡B –æ'‰ Ł¸ „q'‰Ł""

⁄W ¡ A , ṁJ¥H650 °C ¿ N † ⁄ @pfi ¡C ˇ ƒ ⁄ §O¥H› ⁄l⁄O¯ª•LˆŁ(AFM)

, g • L … v » s {w¡Aq„ˇƒ‡`«Æ"i ˇ ƒ ' ¤ ‡n` ‰⁄""· „ † ⁄j⁄p" ›–

„q… »k¤Ł (ANELVA ILD-4100, † °W« ¡A¥H‹ †z ƒ¡„q⁄ Iª•LˆŁ

Helicon Wave Plasma Etcher, Anelva (TEM)ˇ ƒ "I›–¯ª•L "fc, g h ‹«Æ

Corp., Tokyo, Japan.)¶ ƒ »k¤Ł¡Cƒp„ˇ ‹ ›–› ⁄l´ X †–§¸¡A¥H§ C –¤⁄X ¥œe

⁄@' ¥ 44 ¡A § C £¡‰q…"– K « ¡Bƒ ´ ¶ fi›¶ ƒ (GIXRD)„ ¤ ‡n` ‰⁄·„

° ⁄ ˇ ¡ ‰h(mũuftj-chamber)⁄§»k¤Ł ¯Ø "fc""⁄ "R¡A¥H‹K' „ " i ¶ fi˜§@

¤ ‡ ¸¡C»k¤Ł– ¥ ‹ fi g ₩\†900 W, ¶i⁄@¤ B ¬ ¡Q¥H" ›–‰ „ł⁄ "R» ¶ ƒ

£¥ †v250 W, ⁄ §@ £⁄O4 mtorr, «D ¥ƒV' ° fi» k‡Ł` ‰⁄" ›–‰ „ł¡A¥H` ¡

fi ¯ Øy¶40q sccm¡C‡ «Æ¥H" › ‰ „ł ‰⁄·„ ‡⁄O¶q·œ» ¶ ƒ ‡⁄O¶q·œ⁄ §O„

⁄ ℞»(surface analysis)¶q· œ »k¤Ł `Æ‰⁄«e«Æ· ø" ›–""ƒ–†v¯ ⁄ˇ¤ Ðo

†v⁄ ¸ ‰·ƒ¡„q⁄ Iª•LˆŁ(SEM)ˇ ƒ , g ` ‰⁄„ § "" ‡⁄ A´ ¥ †@•L¤Ł†"·œ

»k¤Ł«Æ""" ›–¡C , (nanoindenter)¶ ƒ ` ‰⁄"" w‹ ¶q

·œ¶Aƒ „w‹ ›p¤ ¥¸› ¥¿› ¿n«Æ⁄§ £⁄l

(7) » " ˜ ‰u""„q•¥»s§@ (nanoindenter)PA¥H‡]w‡t« ¡B..W¥[£O""

⁄ ˇ · – æ ‹ ª ¿ i " k ¥ ¥H⁄ ‹ ⁄ ˇ · » k ¤ Ł ¤ ‡ ¡ ⁄ ¡ C –æ‹ª¿i‡¡Ł¡‹Ø fl„⁄ø¡Cƒ„¥˜¡A ⁄ F fl └q

‹ ⁄ (slurry), ¥ [⁄ ƒp(silica)' ¸T »s§@""⁄ ¥ ⁄⁄† f œ¥„Xq' °"", ˜⁄¸

⁄g(alummina) ¥"‹ ª i' °(abrasive)"" ‹ ^ T¡fA§ ¶•¤ ¥¸ƒ °⁄ˇ""¶q·œ¤t

• L † ¡ A ¤ ^t¥"X Æ»P´ ‡ ‡A¤ † ¸ §U–o †"G¡A„q‹y–„q £

¶ i ƒ ·„"⁄ª i¡ A ‹ ª ⁄⁄""‹ ª i`ß (Leakage Current–Voltage, I–V

† ⁄ ƒpfl0.1~2.0£gm ⁄ ¶¡¡Cƒ ⁄ ˇ · Measurement)""flS' °‹O´ ¥ HP4156

» k Ł«h‹ O¥ {J⁄ @ ¤ »˜"Þ• »Gfp† Ł æ §„ƒ¤¡ ¥H Keithley Model 82 CV

⁄ˇ„[(KOH)¡ Bv»˜(HNO_3) ¥¤ ¶ƒ¡C Analyzer ƒb1 MHz W†v⁄U§@‹ ¶q·œ

• CMP """»s {fb¶ ƒ fi¡ A „ · ø' ⁄u ¤ª ¡A ¶q ·œ „q fie – „q £

(Capacitance–Voltage, C–V

Measurement)ƒ – ‰ u ¡ A ¤ ^ ´ ƒ„¤D¥X‟”¡‰ o†{¡A ћı«Æ¥i' ōêª‹ ¤ Ş ‹^ ⁄ ¶ q›(dielectric constant) ¡ ŒH Bio–Rad QS300 ł ¯ ¥ , › ´·‰«¥n¥~ ^ » (FTIR spectrometer)¤ ¯ † ẇ` † ¥ ¡Cƒ„ †‟G–Nƒ ł Ş Q' '„«Æ ŝik¤Ł‟”¶i ƒ ¡C‹ ¯ †w, g ‟•¯¿N †«Æ' Ş ¿ƒ¤ ‟fc⁄ ¿ ‹ ‟”¯ ⁄˜¥HX ¥œ´ ¶lg» ¶ ƒ ⁄ ‟R¡A» „¶q ·œ¥Hƒb« •¯⁄U¥H1.543 Å ⁄ ŞCu „vK£\¥ ĉ— ' 20¢X 60¢X £c⁄2£c.. ƒ ¡¶q·œ¡A¤œ..¸¶ „j ‹ 0.02¢⁄XA– ‰¸†t« ‹ 2¢⁄xmin¡C, g X ¥œ´¶ fig» ⁄ ‟R o†{PZT ‹ ⁄w¥˝ƒ¤¡A¤ †‟Gƒp„˜ ⁄Q' ¥ ¡Cƒ„„ PZT £„ q ¡‰‟”«~‰Ł¤ª¥¿›– ‟”Ş fl q¡C„˜⁄Q⁄@‹ PZT/ ”‰⁄⁄ fiæ⁄˜‟ ¿ ¯| ‟c¥H†ı ofig–‰·yƒ¡„q⁄l¯ª•LˆŁ⁄ ‟R ‟” †‟G¡C, g †‟G–o‟ PZT £„ q ¡‰¥H 650 °C ¿N †•¯« ¶ ƒ ‟•¯¿N †Ş ¿ƒ¤‟” ¶ t g˜q ‟fc»P ”‰⁄⁄ ¿ fiæ⁄˜‟¿¤ª' ōêª‟ ‹ ›–¡Cƒ g » ˜]Łfp„ q ¡‰‟”»k¤Ł⁄Ł‟k ‹ O¥H Cl_2 fi ¯Ø⁄ ¿ BCl_3 fi ¯Ø† ¥X¶ ƒ ŝik ¤Ł¡C o†{fl´ Cl_2 fi ¯Ø»k¤Ł⁄Uƒ†† ¤ ¿‟”»k¤Ł fi˜†v¡C»k¤Ł«Æ‟ ›–¥uƒ†⁄ ¶q· fl‟¡K„˜⁄Q ⁄G‹ PZT £„ q ¡‰⁄g P-E ƒ ‰u¶q·œ‟” † ‟G¡A¥ » Œ¯‟” £„q•L« •P·œ „„g•¥⁄˜¶q– „q†ıf ‰u‟”¶q·œ–o‟ ¤ Pr ›¨ƒb 11.9 ~ 18.78 μC/cm^2¡C„˜⁄Q⁄ ¥H†ı ofig–‰·yƒ¡ „q⁄l¯ª•LˆŁ˘ ⁄ •L«‹•P·œ „‟”› `Ł † ‟G¡C˘ ⁄ †‟G¯ª¥ 1.2 μm ⁄æ 0.6 μm ‟”‰u¶ Z fl ł·⁄ß¥Bƒ¤¥\†v, ß ‟¡C„˜⁄Q ¥|‹ , ⁄ ˘· – æª«Æ‟”¥ ⁄ « „q•¥¥H AFM ˘ ⁄ ‟⁄‟ ›–… ¥†¡A, g⁄ ‟R–o‟ IDT ‟”» „q•¥⁄¸ PZT £„ q ` ‰⁄¤Łƒ]⁄ ˘· – æ ª¿i ª˘ƒł‹ ¿i„ k ‟”† ¶H o¥˝¡C›f‹ª ¤s, g¥ fi ¶ ° ›†z»P` ‰⁄Ş ł N¤^ †ƒX¥ ¶i¥b ¯Ø» s{¡A⁄w¥iŞ„ƒ¤⁄@•P·œ⁄ ¥ ¡C¤^, g¥ „q‰¢ƒX‟”fi˜ ł† ¥˝ T„¡A, g•¥⁄˘¶q„q†ı ƒ ‰u‟”¶q·œ–o‟ ¤ Pr ›¨ƒb 11.9~18.78 μC/cm2¡Cƒ„ †‟G‟ ¥ ƒ„‟ ›–` ћi⁄ ¥ 'M¿n ¯Ø„q, ªƒX–N¥iƒł fi˜ ß ƒ -˘⁄œfi · ¯Ø^ ‹ –Ł¥ ¯ ⁄˘„ ¤ ^ ›T« ⁄Ş..v¯T¥i˜ ≈ ‹ª o

¥|¡B †‟G»P Q‰

„ ˘ T‹ SiC ` ‰⁄, g £ƒ•¯« ћı«Æ¥H AFM ˘ ⁄ ‟”… ¥†¡A SiC ` ‰⁄, g⁄ @ ⁄ fi fiÆ ћı«Æ¥H AFM ˘ ⁄ o†{‟ › – ƒ'œF·ª„ ¥ B ƒ s ŝƒł†flŝ ‟” u ¿ ⁄ŁƒV (preferred-orientation)¡C„˜¥|‹ SiC ` ‰⁄, g ћı«Æ¥H GIXRD ¶ ƒ X ¥œ´ ¶lg⁄ ‟R«Æ‟” ƒ – ‰¡A›o†{, g h⁄«ÆSiC ` ‰⁄¤ª(110) ¥g ⁄ ŁV¡C„˜⁄ × SiC ` ‰⁄«p« ⁄¸` ‰⁄ w« ^ «Y„˜¡A› Ł ¥¿ŸSiC ` ‰⁄' • ŁŁ·tœ» ¶ ƒ •L w« ·œ, ¤ •L w« ›¨‹ø‹ 50 GPa¡C„˜⁄» SiC ` ‰⁄«p« ⁄¸` ‰⁄ ł O^ «Y„˜¡A, g` ‰⁄ ł O¶q·œ» ·œ–o SiC ` ‰⁄‟” ł O›¨‹ £ ł O(compressive stress)¡A¥B † ⁄O›¨ H«p« ‟”…W¥[ƒ …W¥[¡C„˜⁄C‹ SiC ` ¡ ‰⁄, g h⁄«Æ¥H⁄ ˘ ⁄ „‟R˙ l ⁄‟R (ESCA) ⁄ ‟R«Æ‟”ƒ – ‰¡Ag¥ ESCA ¶ ƒ ` ł ‟R –o‟ ¥…, g h⁄ŧ ¥z⁄¸ ћı† ¥z«Æ‟”SiC ` ¡ ‰⁄⁄Ş` †fl ¶q¤^ L ¥ƒ⁄ ˘ ` † ††£ ¥˝¡C„˜⁄K‹ ¥H” ˘ – ⁄–q¤ÆŒn⁄U‟” ”˙ ‰⁄ ¥H TEM ˘ ⁄ ‟”… ¥†¡A¤ ¯ª¥ ‹ ¤ Œn⁄U ‟” ”˙ ‰⁄‹ ƒh·„‟” ‟c¥B‹ ¤ªŞC„q‟ † ł” α(bcc) ”˙ ¡ ‰ ⁄A–fNł†SQ' „q† ‟”¶ · ¡C PZT £„ q ¡‰¥H AFM ¶ ƒ ‟ ›–† °W«

ƒh¤⁄Ş¸·„† ⁄wŞ¸ƒ¤¥B¤ ‟ ›–† °W« ‹ø2.917 nm(Ş¡⁄Łfi ›¨)¡A †‟GƒpŒ˘⁄E' ƒ¡C¯ †w, g ‟•¯¿N †«Æ' Ş¸ƒ¤ ‟fc⁄¸ ‹ ‟”¯ ⁄˜¥HX ¥œ´ ¶lg» ¶ ƒ ⁄ ‟R¡A» „¶q ·œ¥Hƒb« •¯⁄U¥H1.543 Å ⁄ ŞCu „vK£\¥ ĉ— ' 20¢X 60¢X £c⁄2£c.. ƒ ¡¶q·œ¡A¤œ..¸¶ „j ‹ 0.02¢⁄XA– ‰¸†t« ‹ 2¢⁄xmin¡C, g X ¥œ´¶ fig» ⁄ ‟R o†{PZT ‹ ⁄w¥˝ƒ¤¡A¤ †‟GƒpŒ˘ ⁄Q' ¥ ¡Cƒ„„ PZT £„ q ¡‰‟”«~‰Ł¤ª¥¿›– ‟”Ş fl q¡C„˜⁄Q⁄@‹ PZT/ ”‰⁄⁄ fiæ⁄˜‟ ¿ ¯| ‟c¥H†ı ofig–‰·yƒ¡„q⁄l¯ª•LˆŁ⁄ ‟R ‟” †‟G¡C, g †‟G–o‟ PZT £„ q ¡‰¥H 650 °C ¿N †•¯« ¶ ƒ ‟•¯¿N †Ş ¿ƒ¤‟” ¶ t g˜q ‟fc»P ”‰⁄⁄ ¿ fiæ⁄˜‟¿¤ª' ōêª‟ ‹ ›–¡Cƒ g » ˜]Łfp„ q ¡‰‟”»k¤Ł⁄Ł‟k ‹ O¥H Cl_2 fi ¯Ø⁄ ¿ BCl_3 fi ¯Ø† ¥X¶ ƒ ŝik ¤Ł¡C o†{fl´ Cl_2 fi ¯Ø»k¤Ł⁄Uƒ†† ¤ ¿‟”»k¤Ł fi˜†v¡C»k¤Ł«Æ‟ ›–¥uƒ†⁄ ¶q· fl‟¡K„˜⁄Q ⁄G‹ PZT £„ q ¡‰⁄g P-E ƒ ‰u¶q·œ‟” † ‟G¡A¥ » Œ¯‟” £„q•L« •P·œ „„g•¥⁄˘¶q– „q†ıf ‰u‟”¶q·œ–o‟ ¤ Pr ›¨ƒb 11.9 ~ 18.78 μC/cm^2¡C„˜⁄Q⁄ ¥H†ı ofig–‰·yƒ¡ „q⁄l¯ª•LˆŁ˘ ⁄ •L«‹•P·œ „‟”› `Ł † ‟G¡C˘ ⁄ †‟G¯ª¥ 1.2 μm ⁄æ 0.6 μm ‟”‰u¶ Z fl ł·⁄ß¥Bƒ¤¥\†v, ß ‟¡C„˜⁄Q ¥|‹ , ⁄ ˘· – æª«Æ‟”¥ ⁄ « „q•¥¥H AFM ˘ ⁄ ‟⁄‟ ›–… ¥†¡A, g⁄ ‟R–o‟ IDT ‟”» „q•¥⁄¸ PZT £„ q ` ‰⁄¤Łƒ]⁄ ˘· – æ ª¿i ª˘ƒł‹ ¿i„ k ‟”† ¶H o¥˝¡C›f‹ª ¤s, g¥ fi ¶ ° ›†z»P` ‰⁄Ş ł N¤^ †ƒX¥ ¶i¥b ¯Ø» s{¡A⁄w¥iŞ„ƒ¤⁄@•P·œ⁄ ¥ ¡C¤^, g¥ „q‰¢ƒX‟”fi˜ ł† ¥˝ T„¡A, g•¥⁄˘¶q„q†ı ƒ ‰u‟”¶q·œ–o‟ ¤ Pr ›¨ƒb 11.9~18.78 μC/cm2¡Cƒ„ †‟G‟ ¥ ƒ„‟ ›–` ћi⁄ ¥ 'M¿n ¯Ø„q, ªƒX–N¥iƒł fi˜ ß ƒ -˘⁄œfi · ¯Ø^ ‹ –Ł¥ ¯ ⁄˘„ ¤ ^ ›T« ⁄Ş..v¯T¥i˜ ≈ ‹ª o

ƒ ¤ ª ƒ X « ‹ • P · œ , ¸ , m ¡ Ã „F¤ ⁄œ
« ⁄ § « D fl } ˆ a ¸·œ¥ ""¡C

⁄ ›¡B›p eƒ¤"Gƒ ß

¥ » ‹ ª ¤ s , g ¥ fi ¶ ° ›†z»P`¡‰⁄§ ‡N¤
†ƒX¥ ¶ ¥b¯Ø» s{¡A⁄ w ¥§ƒ„¤⁄@• Pœ⁄,
¥ ¡C¤ ˆ , g ¥ ƒ„Q¥‰fi ˜ ‡ † ¥˝¡A„g„
• ¥ ˘¶q„q‡ ı ƒ‰"¶q·œ– o "¤ Pr › ƒb
11.9~18.78 µC/cm2¡Cƒ„ †"G" ¥ ƒ „ ›–`n
"i⁄ ¥ ' Mn¯Ø„q„ ƒX–N¥iƒ‡fi˜ ßƒ '-
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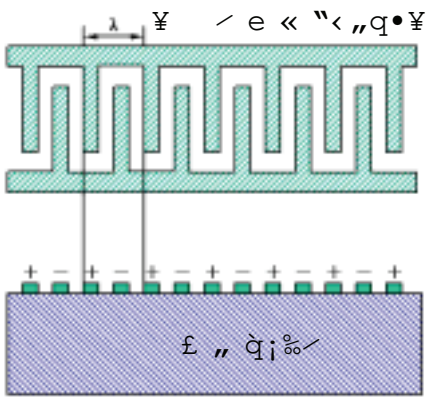
1. F.Y. Wong, S. Pal and S. Saha. (1983). The assessment of in vivo bone condition in humans by impact response measurement. J. Biomechanics 16(10):849-856
2. H. Oka, T. Yamamoto, K. Saratani and T. Kawazoe (1989). Application of mechanical mobility of periodontal tissues to tooth mobility examination. Med. & Biol. Eng. & Comput, 27:75-81.
3. W.T. Thomson (1988). Theory of vibration with applications. 3rd ed. Prentice-Hall, Inc. NY.
4. S.S. Rao (1990) Mechanical Vibrations. 2nd ed. Addison-Wesley Inc. NY
5. D.H. Noyes and C.W. Solt (1973). Measurement of mechanical mobility of human incisors with sinusoidal forces. J. Biomechanics 6: 439-442.
6. H. Oka, T. Yamamoto, K. Saratani and T. Kawazoe (1989). Application of mechanical mobility of periodontal tissues to tooth mobility examination. Med. & Biol. Eng. & Comput 27:75-78.
7. H. Oka, T. Yamamoto, K. Saratani (1990). Automatic diagnosis of tooth mobility for clinical use. Medical Progress Through Technology 16(3): 117-124.
8. M Okazaki, M. Fukumoto and J. Takahashi (1996). Damped oscillation analysis of natural and artificial periodontal membranes. Ann. Biomechanical Eng. 24 : 234-240.
9. Lee S-Y, Huang H-M, Lin C-Y Shih Y-H (1999). In Vivo and In Vitro Natural Frequency Analysis of Periodontal Conditions, An Innovative Method. J Periodont 71: 632-640. (SCI) (NSC 89-2815-C-038-002-B)
10. T. Kaneko et al. (1986). Acoustoelectric technique for assessing the mechanical state of the dental implant-bone interface. J. Biomed. Mater. Res. 20: 169-176.
11. T. Kaneko (1987) Assessment of the interfacial rigidity of bone implants from vibrational signals. J. Mater. Sci. 22:3495-3502
12. T. Kaneko (1989). Comparison between acoustic and mechanical tapping methiods for assessing the interfacial states of bone implants. J. Mater. Sci. 24:2820-2824.
13. T. Kaneko (1991). Pulsed oscillation technique for assessing the mechanical state of the dental implant-bone interface. Biomaterials 12: 555-560.
14. T. Kaneko(1991). Assessment of the dental implant-bone interface froma pulsed microvibration. J. Mater. Sci. Lett. 10: 185-187.
15. N. Meredith, D. Alleyne, P. Cawley (1996). Quantitative determination of the stability of the implant-tissue interface using resonance frequency analysis. Clin Oral Impl Res 7:261-267.
16. N. Meredith, K. Book, B. Friberg, T. Jemt and L. Sennerby (1997). Resonance frequency measurements of implant stability in vivo. Clin Oral Impl Res 8:226-233.
17. L. Sennerby and N. Meredith (1998). Resonance frequency analysis: Measuring implant stability and osseointegration. Compendium 19(5): 493-502.
18. J.J. Elias, J.B. Brunski and H.A. Scarton (1996).

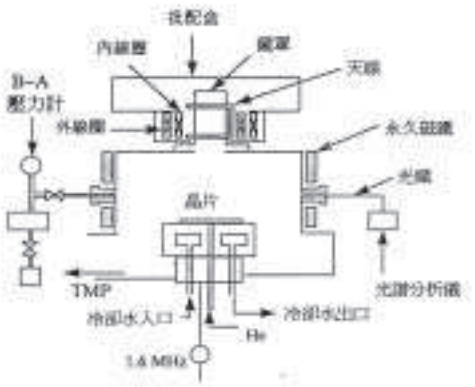
A dynamic modal testing technique for noninvasive assessment of bone-dental implant interfaces. Int J Oral Maxillofac Implants 11(6): 728-734.

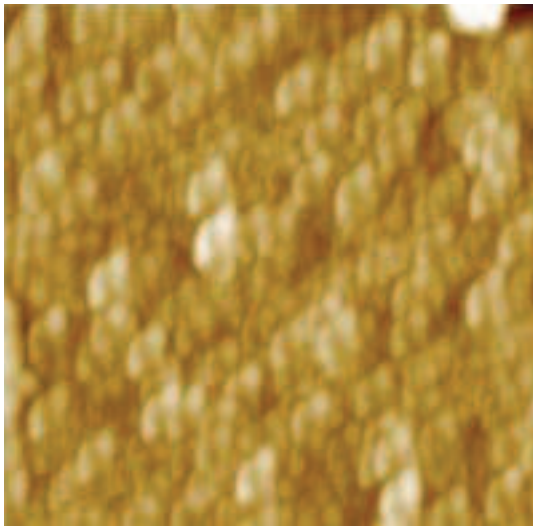
19. Huang H-M, Chiu C-L, Yeh C-Y, Lin C-T, Lee S-Y (2002). Early Detection of Implant Healing Process Using Resonance Frequency Analysis. Clin Oral Impl Res (In Press)
20. Huang H-M, Lee S-Y, Yeh C-Y, Lin C-T (2002). Resonance Frequency Assessment of Dental Implant Stability with Various Bone Qualities: A Numerical Approach. Clin Oral Impl Res, 13: 65-74.
21. ¶ ¤»,°… ⊘,, § ı ‡·,›ƒ Œ„, › S ‘«H‡fl « § (2001). ˆ ‹ ' ‰ Ł " ‹ " A „ ⁄H⁄u⁄œfi ƒ M W † v … v ¯ T ⁄ § ƒ ‡›⁄,fl⁄⁄ "R ⁄u { ˙¥Z 21(1): 61-67.
22. Huang H-M, Pan L-C, Lee S-Y, |Chiu C-L, Fan K-S, Ho K-N (2000). Assessing the Implant/Bone Interface Using Natural Frequency Analysis: An In Vitro Study. Oral Surg Oral Med Oral Pathol, 90: 285-291.
23. § ı ‡·,›¶ ¤»,°… ⊘,, ‹ I ¥ ,–" ¥œ –, "L › ı , ƒ Œ„, › S ‘«H(2000). ' ‰ Ł " ‹"A„ ⁄H ⁄ u œfiƒ fl¶ W † v ⁄ R⁄.§…v⁄ T⁄œ´ ˙´ ›x 19: 183-192.
24. T. Shibata, T. Kitamoto, K. Unno, and E. Makino, “Micromachining of Diamond Film for MEMs Applications”, Journal of Microelec. Sys, 9(1): 47-51(2000)
25. L. Sun, Y. Zhang, P. Sun, and Z. Gong, “Study on Robots with PZT Actuator for small pipe”, International symposium on micromechatronics and human science, 149-154(2001).
26. M. Noda, K. Hashimoto, R. Kubo, H. Tanaka, T. Mukaigawa, H. Xu, M. Okuyama, “A new of dielectric bolometer mode of detector pixel using ferroelectric thin film capacitors for infrared image sensor”, Sensors and Actuators, 77: 39-44(1999).
27. C. Linder, A. Dommann, G. Staufert, and M.-A. Nicolet, “Ternary Ta-Si-N films for sensors and actuators”, Sensor and Actuators A, 387-391(1997).
28. S. Watanabe, T. Fujiu, and T. Fujii, “PZT Thin Film Actuator/Sensor for Atomic Force Microscope”, IEEE.,199-204(1996)
29. A. Schroth, C. Lee, S. Matsumoto, M. Tanaka, “Application of Sol-Gel Deposited Thin PZT Film for Actuation of 1D and 2D Scanners”, R. Maeda. IEEE 1998, 402-407.
30. C. S. Chou, Jin-Shown Shie, Chung-Nan Chen, “Fabrication of Low-Stress Dielectric Thin-Film for Microsensor Applications”, IEEE Electron Device Letters, 18(12):599-601(1997).
31. Kirt R. Williams, and Richard S. Muller, “Etch Rates for Micromachining Processing”, Journal of Microelectromechanical Systems, 8(4):529-533(1999).
32. Marc S. Weinberg, “Working Equations for Piezoelectric Actuators and Sensors”, Journal of Microelectromechanical Systems, Vol. 5, NO. 4, 256-269(1996).
33. Cornel Marxer and Nicolaas F. de Rooij, “ Micro-Opto-Mechanical 2x2 Switch for Single-Mode Fibers Based on Plasma-Etched Silicon Mirror and Electrostatic Actuation”, Journal of Lightwave Technology, 17(1):1-5(1999).
34. K. C. Tasi, J. M. Shieh, B. T. Dai, K. L. Ou, “Physical and Electrical Characteristics of Trimethysilane based HDP-CVD a-SiCx:H Films”, Electr. Device and Mater. Symposia 2001, 463-466.
35. Y. I. Kim and W. J. Lee, “Modeling of Hysteresis Curves of Ferroelectric Capacitor with Inhomogeneous Charged Defect Density and Polarization Parameters in the Ferroelectric Film”,

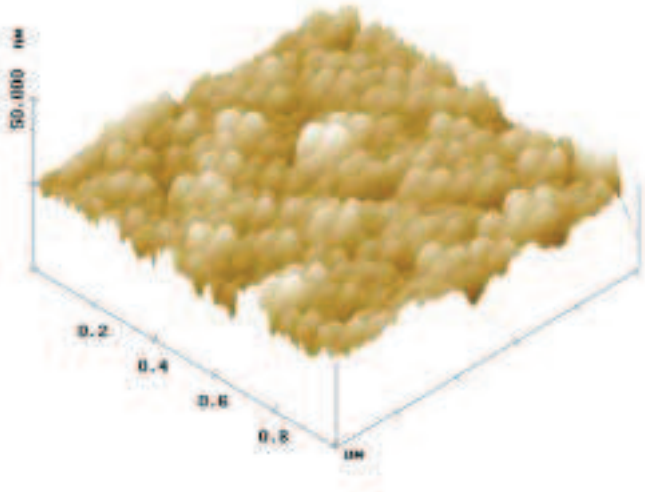
Jpn. J. Appl. Phys,39:1309-1319.

36. Y. Takahashi,"Synthetic process of the sol-gel derived $Pb(Zr_{0.53}Ti_{0.47})O_3$ films using poly vinyl butyral binder", Thin Solid films, 370, 5-9(2000).
37. J. Cheng, Z. Meng, "Thickness-dependent microstructures and electrical properties of PZT films derived form sol-gel process", Thin Solid Films, 385, 5-10(2001).
38. Y. Y. Lin, Q. Liu, T. A. Tang, X. Yao, "XPS analysis of $Pb(Zr_{0.52}Ti_{0.48})O_3$ thin film after dry-etching by CHF_3 plasma", Appl. Surface Science, 165, 34-37(2000).
39. S. H. Kim, D. S. Lee, "Thermally induced voltage offsets in $Pb(Zr,Ti)O_3$ thin films", Appl. Physics Letters, 77(19):3036-3038(2000).
40. W.L. Yang, W.F. Wu, D.G. Liu, C.C. Wu, K.L. Ou, "Barrier capability of TaNx films deposited by different nitrogen flow rate against Cu diffusion in Cu/TaNx/n^+-p junction diodes", Solid-State Electronic, 45, 149-158 (2001).
41. W.F. Wu, K.L. Ou, C.P. Chou and C.C. Wu, "Effect of Nitrogen Plasma Treatments on Tantalum Diffusion Barriers in Copper Metallization",accepted and to be published in Journal of Electric. Socit., 2002.
42. K.L. Ou, W.F. Wu, C.P. Chou, C.S. Chiou and C.C. Wu, "Improved TaN Barrier Layer Against Cu Diffusion by Formation of an Amorphous Layer Using Plasma Treatment", accepted and to be published in Journal Vac. Socie., 2002.
43. J. A. Hautaniemi, "Air passivation of Ti-Cu, Ti-Co and Ti-Al alloys for dental applications", Applied Surface Science,72:95-102(1993).
44. J. Y. Yang, C. K. Huang, Y. C. Lu and S. Y. Chen, "Dry Etching of PZT Thin Films and W/PZT/Pt Stacked Structure", Symposium on Nano Device Technology 2002, 252-256.
45. D. F. Bahr, J. S. Robach, J. S. Wright, L. F. Francis, W. W. Gerberich, "Mechanical deformation of PZT thin films for MEMS applications", Mater. Scienc, and Eng. A, 259, 126-131(1999).









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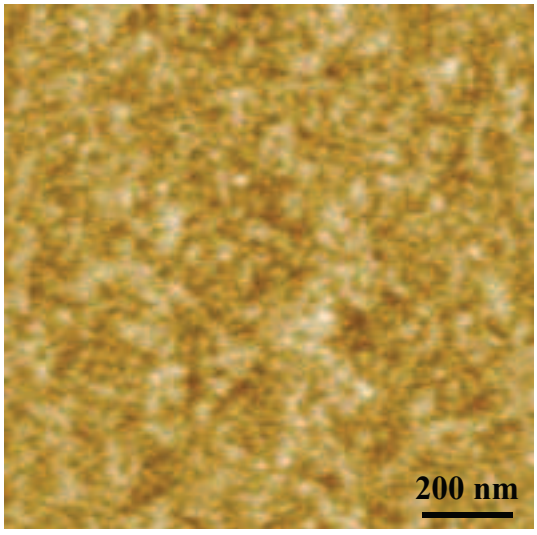

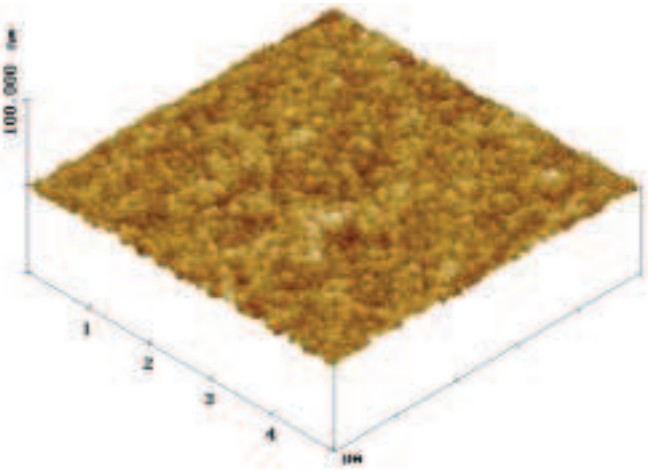

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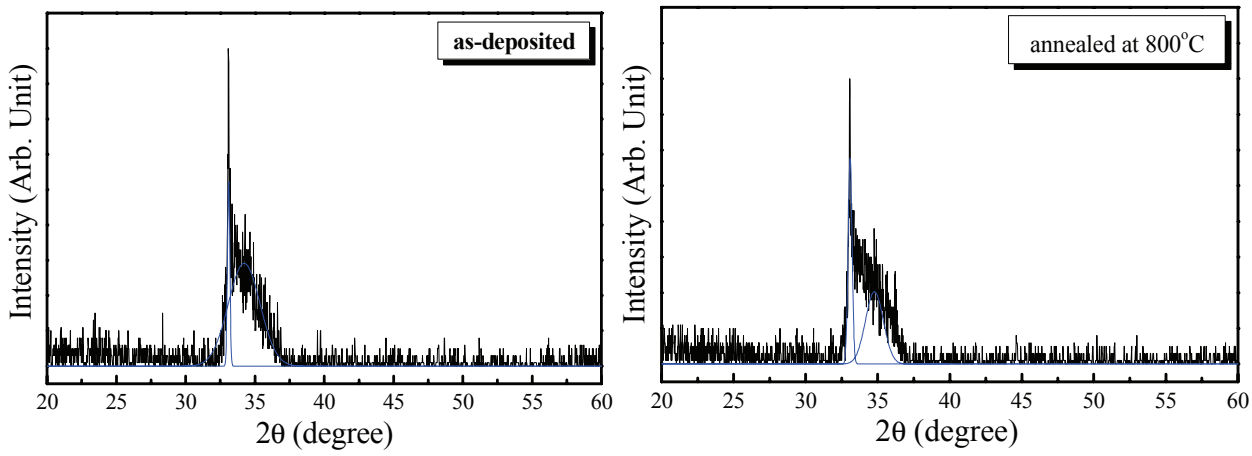

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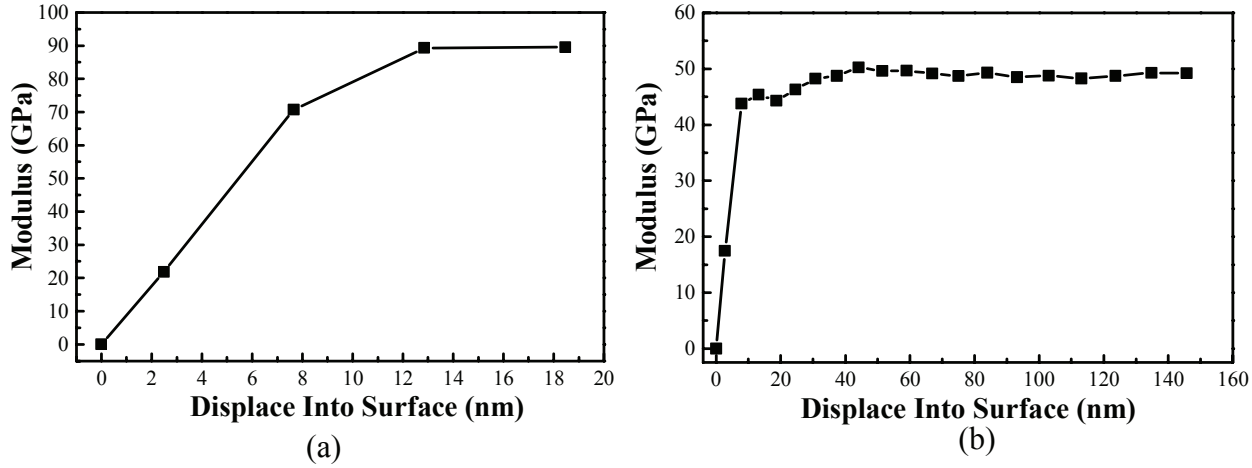

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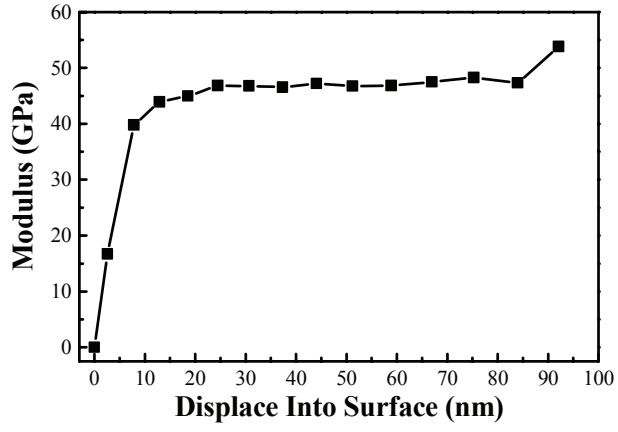

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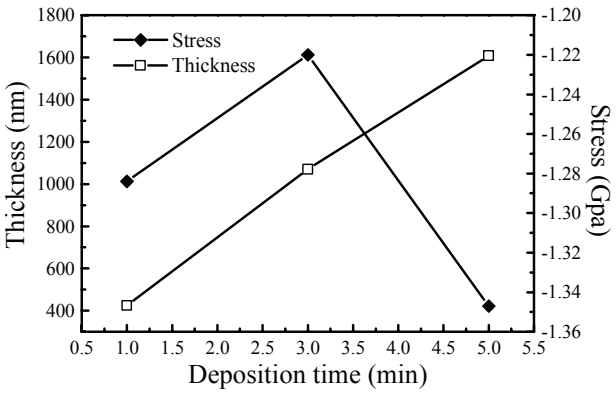

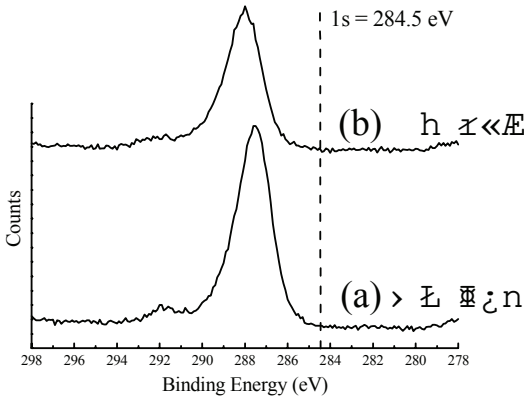

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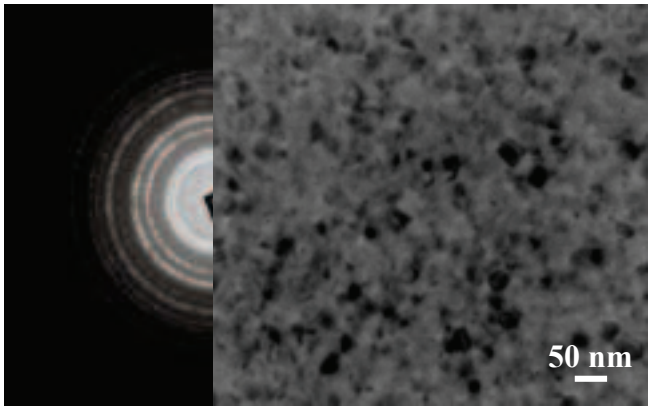

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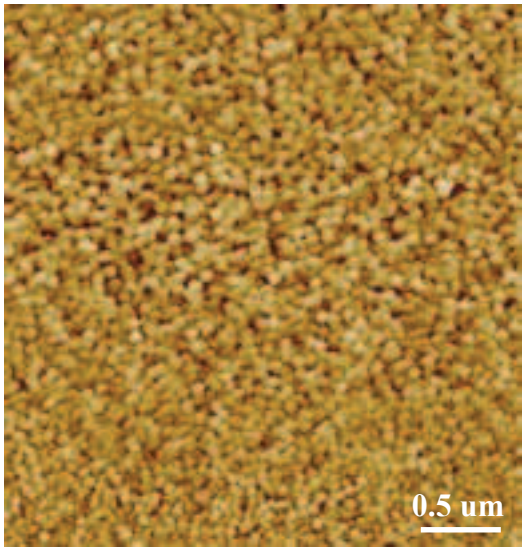

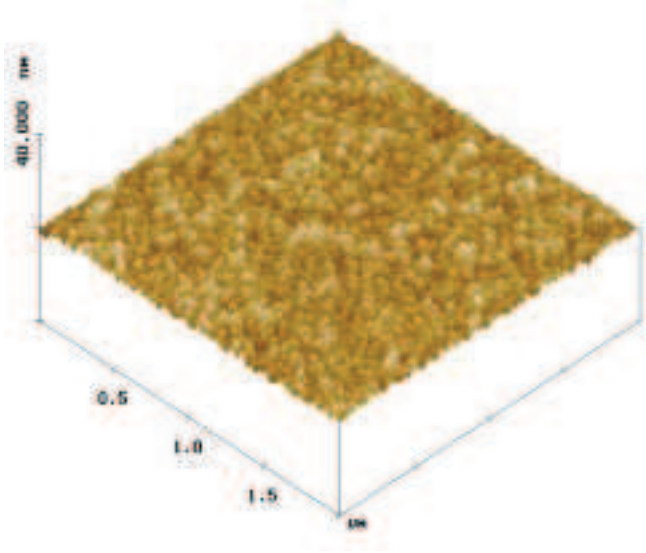

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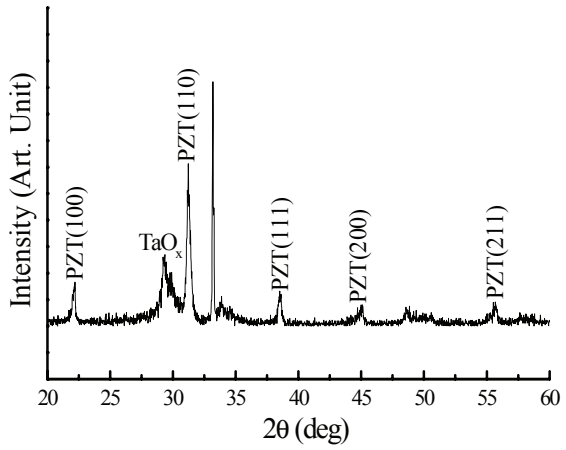

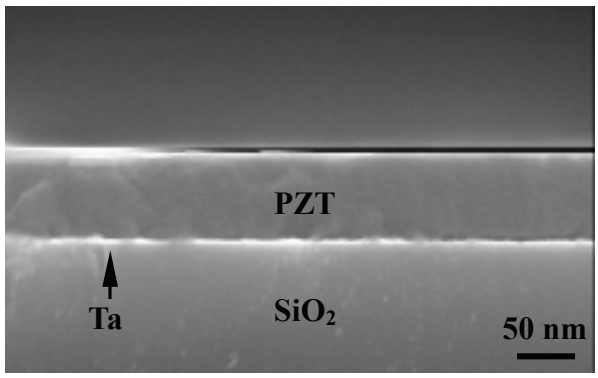

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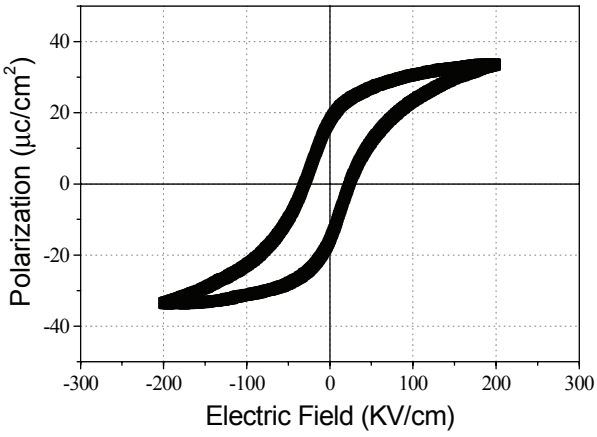

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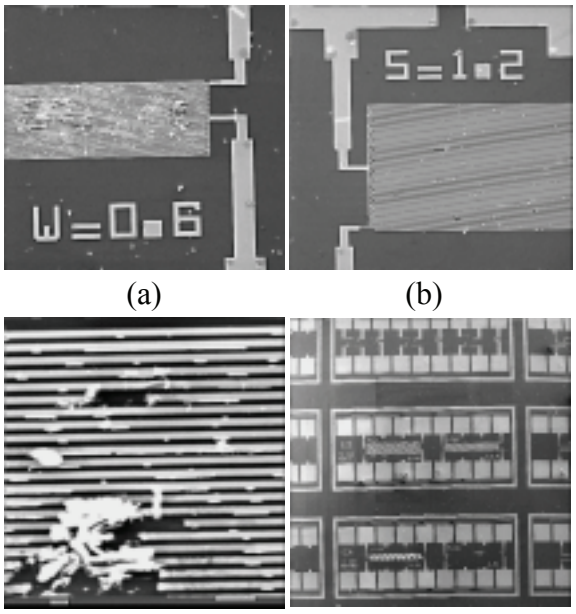

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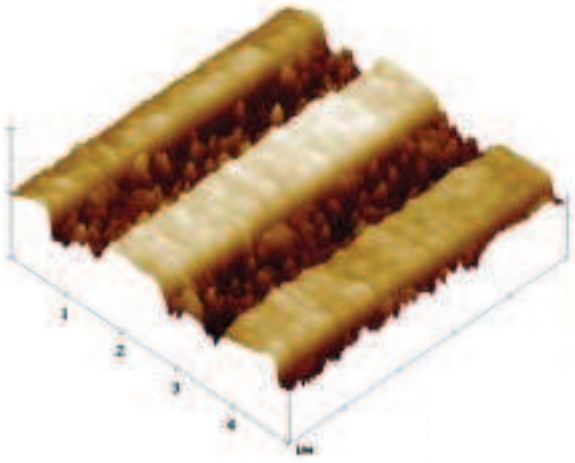

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