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COMMENT

Comment on 'Creation of P_b interface defects in thermal Si/SiO_2 through annealing'

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Abstract. Some suggestions are offered to explain the discrepancies between the work of Stesmans and others.

In a recent letter [1] to this journal, Stesmans and Afanas'ev present data which disagrees markedly with previously published results [2] of a seemingly identical experiment of which the authors seem to be unaware. [1] presents the results of vacuum annealing of (111) Si/SiO_2 interfaces in order to study the depassivation and generation of Si dangling bond interface defects (P_b centres). It shows a new defect generation process above 640 °C. On the other hand, figure 1 of [2] shows ostensibly the same experiment, for anneal temperatures up to 800 °C, with no evidence for such a generation step. The discrepancy between these two sets of data deserves to be addressed.

The authors of [1] offer no explanation of their new finding, even though they are aware that their results differ from the canonical picture given by Brower [3]. (Figure 1 of [2] is essentially a confirmation of Brower's work.) Here I can offer some suggestions. The discrepancy may result either from a difference in the nature of the starting Si/SiO_2 sample or from a difference in the method of thermal treatment. Regarding the first possibility, Stesmans [4, 5] has previously described his wafer cleaning procedure, which has an acetone rinse as the last step, in contrast to the industry-standard cleaning procedure which is designed to remove organic and metal contaminants. We should therefore be concerned about possible effects of carbon impurities [6]. Brower likewise cleaned his wafers in an organic solvent just prior to oxidation [7], but the effect of carbon depends in detail on the oxidation ramp-up conditions [8]. Regarding the second possibility, a difference in thermal treatment methods, I note that the vacuum anneals in [1] are done at a pressure of at most 4×10^{-7} torr, lower than that used by either [2] (3×10^{-6} torr) or [3] (5×10^{-5} torr). Trace amounts of water vapour are known [9, 10] to have a profound effect on the passivation of P_b centres. The lower pressure used by Stesmans may be significant.

Whatever the explanation, the new results presented in [1] may help to resolve a number of long-standing discrepancies between Stesmans' work and others', e.g. why he has consistently [5, 11, 12] reported P_b densities after vacuum annealing which are two to four times greater than those reported by Brower [3], whose value is in good agreement with my own extensive experience [2, 13] with samples vacuum annealed up to 850 °C. Indeed, the initial depassivation behaviour of Stesmans and Afanas'ev, for anneal temperature less than 640 °C, shows a saturation toward a P_b density of approximately 4.5×10^{12} cm^{-2}, which agrees to within experimental uncertainty with the results of [2] and which is also closer to the value Stesmans [4] and others [14] have reported in dry-oxidized samples prior

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to hydrogen passivation. It is only after vacuum annealing that Stesmans' results diverge, and in the same samples he has also reported unusual passivation behaviour [11] as well as electron spin resonance lineshapes attributed to dipolar interactions [5] which others [15] have been unable to observe at the lower defect densities. It appears that both of these latter phenomena may be related to the 'excess' P_b centres reported in [1].

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