ASIA-PACIFIC
SOLAR RESEARCH CONFERENCE

TMAH based highly reproducible c-Si texturing

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Abstract: Texturing of the sunward surface of solar cells is critical to reduce light reflectance losses, fulfilling the gain of a high Jsc. In this abstract, we address a newly developed texturing method for c-silicon wafers with the advantages of non-metal contamination, high reproducibility, short process time (12min-20min), small random pyramids(~3-4 um), moderate texturing temperature.

In our texturing process, an organic TMAH (tetramethyl ammonium hydroxide) is used as an anisotropic etchant replacing the commonly used inorganic KOH to avoid any metal contamination due to the possible trace metal impurity in a commercialized KOH product [1]. In addition, a commercialized texturing additive "RENA monoTEX" was chosen as an alternative to the generally used alcohol additive of IPA [2]. The boiling point of IPA is closed to the texturing process temperature (~80°C) resulting in an uncontrollable solution component during the process and unrepeatable textured surfaces among different batches [3]. In contrast, the agent of monoTEX is operating far below the boiling point of its component leading to great reproducibility. Moreover, this TMAH-monoTEX texturing solution can be reused maintaining identical texturing results after several batched of sample processes.

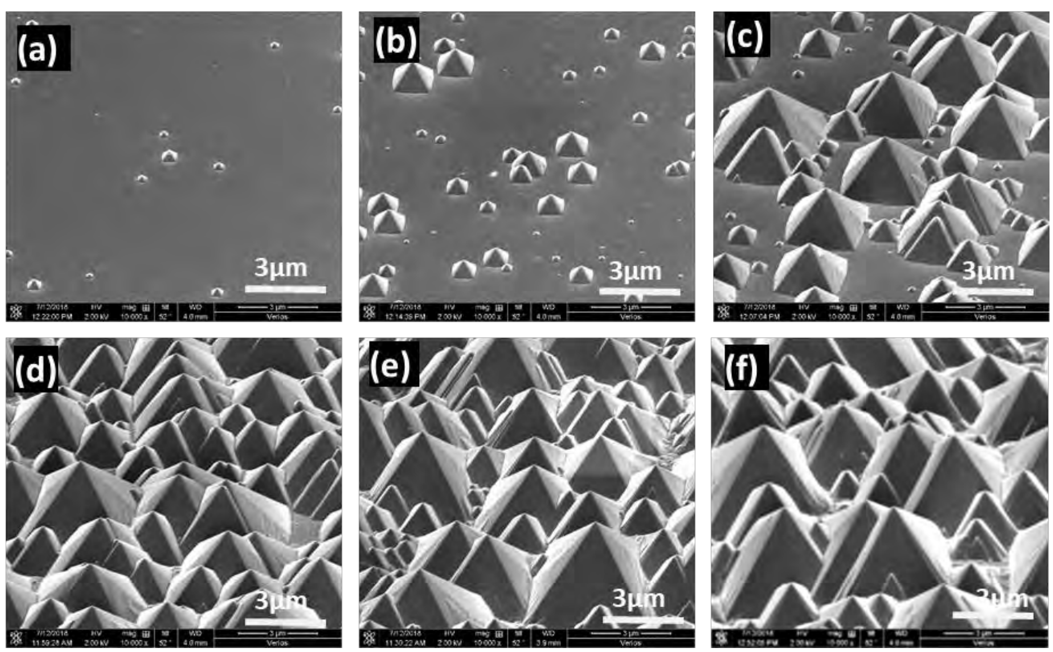

Figure 1 Emerging of pyramids during a TMAH-monoTEX texturing process. (a) 2min,(b) 4min, (c) 8min, (d) 12min, (e)20min, (f) 30min. A magnification factor of 10000X was used for all the images.

Figure 1 shows SEM images of the Si surface with various TMAH-monoTEX texturing periods. It is surprising that the texturing starts very fast with small uniform pyramids distribution being observed after 2 minutes. A complete texturing ends after 20 minutes, which is consistent with the revolution of reflectance shown in Figure 3(a). A further texturing to 30 minutes seems increases the pyramid size a little, but the reflectance dose not drop sequentially. For a 20 minute textured sample, a low reflectance of 11% (@ 800nm) was obtained with pyramid width of ~4μm.

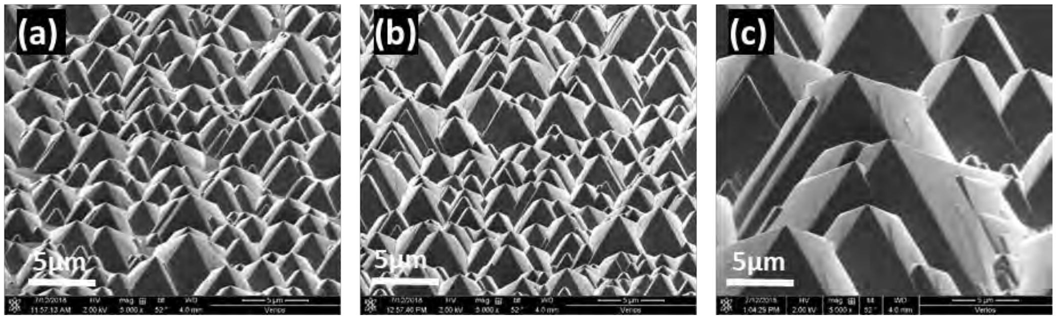

Figure 2 Compare the morphology of textured Si surfaces with different texturing solution. (a) TMAH-monoTEX, (b) KOH-monoTEX, (c) TMAH-IPA

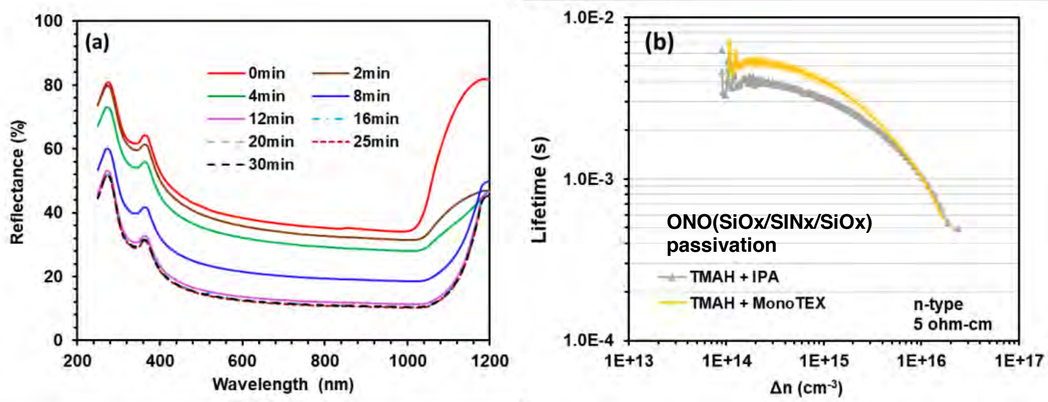

Figure 3 (a) Reflectance evolution with TMAH-monoTEX texturing time; (2) Lifetime curves for TMAH-IPA and TMAH-mono textured silicon samples

From Figure 2(a) and (c), it is noticeable that the resulted pyramids by this TMAH-monoTEX method is much smaller than that fabricated with a TMAH-IPA method (~10um), which is a general texturing process in our lab. Lifetime curves of ONO (SiOx/SiNx/SiOx) passivated textured silicon wafer are illustrated in Figure 3 (b) [4], where a bit higher lifetime is observed by the TMAH-monoTEX method in comparison with our commonly used TMAH-IPA texturing method.

In summary, the proposed texturing method here is an excellent choice for fabricating high efficiency Si solar cells in the laboratory with zero tolerance to any metal contamination.

Reference:

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