"Aluminum induced crystallization of germanium patterns as pseudo-substrates for solar cells epitaxy"

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Re-crystallized germanium platelets on glass support is a potential route toward low-cost substrates for III-V solar cells. A possible way to mimic standard Ge mono-crystalline wafers is to fabricate patterned substrates in which each motif recrystallize as a single mono-crystalline domain. We use here optical lithographic process to investigate Metal Induced Crystallization of Ge (MIC-Ge) of patterned samples on silica support. Amorphous-Ge (a-Ge), 20 nm thick, is recrystallized at low temperature (220 – 300 °C) in the presence of aluminum (Al). Similarly to non-patterned samples, the crystallization process proceeds in two phases: one creating not well oriented crystalline Ge dendrites (MIC-1) and one creating mostly (111) oriented Ge platelets (MIC-2). We observe that the defective dendrites of the MIC-1 are the nucleation points for the preferred MIC-2 phenomena [1].

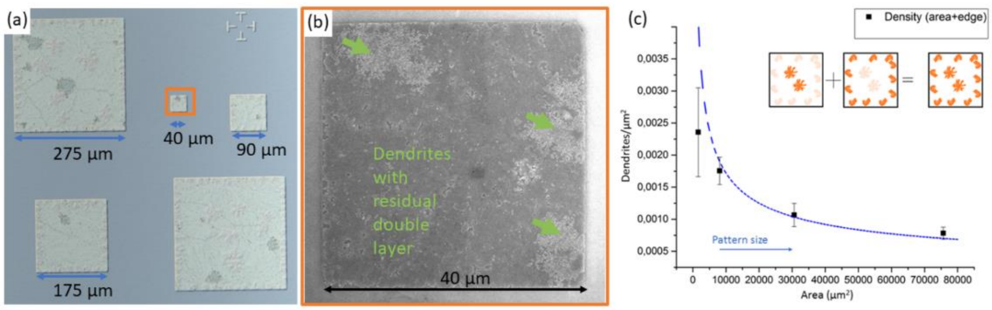

Figure 1. (a) Optical characterization (Nomarski) of Ge patterns of different size on silica. (b) SEM characterization of one Ge pattern 40 µm large. Green arrows indicate the location of the defective Ge dendrites. (c) Ge dendrites density as a function of the pattern size.

In order to reduce the number of MIC-1 dendrites, we investigate in Figure 1 different pattern sizes (275 µm, 175 µm, 90 µm, 40 µm and 2.7 µm (not shown)). We observe that the edges of the patterns are preferential nucleation sites for the MIC-1 dendrites. Therefore, decreasing the size of pattern leads to an increase of the defect density due to the change in the perimeter to surface ratio.

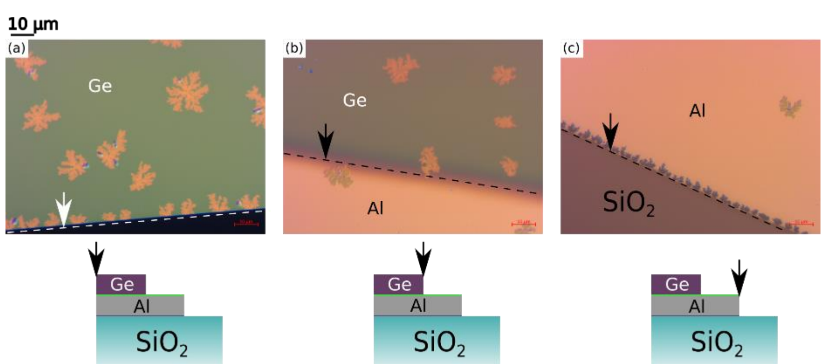

Figure 2. Edges effect on the Ge dendrites nucleation: (a) sample edge; (b) Ge layer edge; (c) Al layer with Ge 'underlayer' and GeO_x 'interlayer' edge.

We find that lithographic process during the patterning of the Al layer is largely responsible for the observed high defect density at the edges of the pattern (Figure 2). Thus, we can avoid the creation of additional dendrites by patterning only the Ge top layer. The obtained Ge crystalline patches are good candidates for the subsequent epitaxy of GaAs by MBE or MOCVD to obtain III-V solar cells on silica.

[1] D. Pelati et al., Crystal Growth & Design (accepted 2017)