The well-known Metal Induced Lateral Crystallization (MILC) process [1] is investigated in-situ in transmission electron microscope with a heating sample holder. Model structures were grown onto thermal oxide coated Si substrates consisting of a CVD grown amorphous silicon (a-Si) layer, a silicon oxide (SiO\textsubscript{x}) mask layer and a thin nickel layer as shown in Fig 1. Windows (10x10 µm\textsuperscript{2} and 100x10 µm\textsuperscript{2}) were opened in the SiO\textsubscript{x} mask layer where the Ni came in contact with the amorphous Si layer. Ni and amorphous Si thicknesses were selected such that all the Ni could be accommodated in the underlying Si during nickel-silicide (NiSi\textsubscript{2}) formation. Cross sectional TEM specimens of the relevant sample areas near the window edge were prepared with the Focussed Ion Beam (FIB) technique and heat treated in the microscope. The initial state of the specimen before the heating experiment is shown in Fig 2. Gradual nickel-silicide formation starting from the interface was observed in-situ at temperatures as low as 250°C. A sequence of images taken at different stages of the NiSi\textsubscript{2} formation is shown in Fig 3. Further increasing of the temperature caused the whole Ni amount in the window area to diffuse into the a-Si layer and the lateral crystallization to start originating from newly formed NiSi\textsubscript{2} seeds. It has been shown earlier [2] that the Ni-MILC phenomenon is based on the formation of NiSi\textsubscript{2} precipitates and their subsequent migration through a-Si film, leaving a trail of crystalline Si grown on the lattice-matched silicide, NiSi\textsubscript{2}, (misfit only 0.4% to Si). At higher temperatures up to 650°C the lateral crystallization process was observed and investigated with analytical tools to prove the migration of NiSi\textsubscript{2} phase.

References

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Fig. 1: Construction of the model structure and in-situ MILC experiment.

Fig. 2: Initial state of the FIB prepared TEM specimen before annealing.

Fig. 3: Stages of NiSi₂ formation at T=250°C. Nucleation of the silicide phase starts at several points of the Ni/Si interface.