# C-MOS Gate Silicide Analysis by Atom Probe Tomography

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## ABSTRACT

Metal silicides are widely used as contacts and interconnections to source and drain in microelectronics devices. The Nickel monosilicide (NiSi) is integrated in advanced technologies because of the following advantages : low resistivity and low Si consumption, formation controlled by Ni diffusion, adequate work function for metal gates[i,ii]. It has been shown that the addition of Pt in the Ni film increases the nucleation temperature of $NiSi_2$ by approximately 150 °C, stabilizes the NiSi films[iii] and increases the temperature of NiSi agglomeration [iv]. Despite the large number of study about Ni silicide the chemical analysis of transistor silicide remains a great challenge.

In this paper, the gate silicides of n-type metal-oxide-semiconductor field effect transistor (MOSFET) were analyzed by atom probe tomography (APT). The sample analyzed is a 28 nm transistor from S-RAM produced by STMicroelectronics. The transistor has been extracted from the wafer (Fig.1a) by focused- ion-beam (FIB) site-selective lift-out and then prepared for APT analysis employing a serie of FIB annular millings (Fig.1b). APT analysis allows to measure the Pt and As concentration profile with sub-nanometric spatial resolution (Fig. 1c and d), evidencing a gradient in Pt concentration within NiSi and an As accumulation at NiSi/Si interface (Fig.1e). Moreover statistical distribution analysis and the detection of PtAs molecular ions in the mass spectrum suggest the formation of PtAs precipitates in NiSi phase.

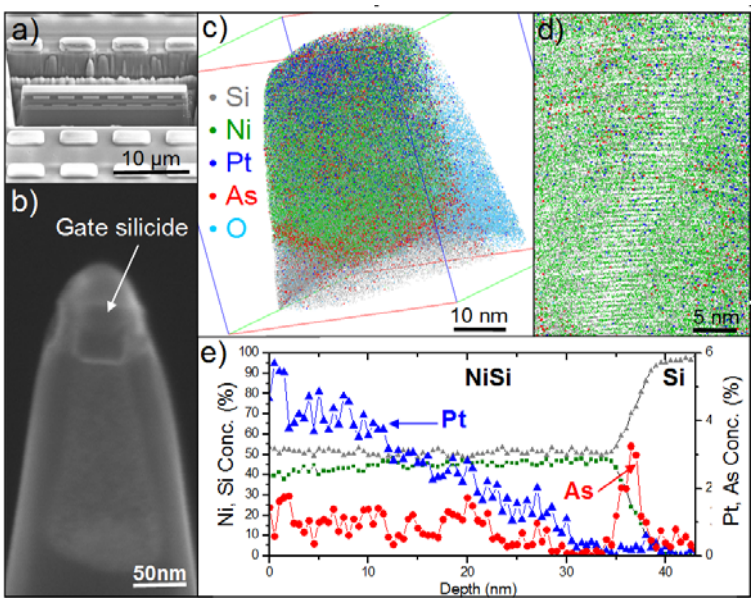


**FIGURE 1.** (a) Scanning electron microscopy image of FiB cut S-RAM lamella (b)Focused ion beam prepared APT specimen containing a transistor; (c) APT reconstruction of C-MOS gate silicate; (d) Details of analyzed volume showing NiSi atomic planes; (e) Concentration profile along tip axis direction.

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