I. INTRODUCTION

The low resistivity CoSi$_2$ binary compound obtained by the reaction of a thin cobalt film on a thick poly or single crystal silicon is, according to the literature, nucleation controlled [1]. There are indications that, if evaporated cobalt and silicon films are used, the formation of CoSi$_2$ seems not to be affected by the presence of a nucleation barrier [2]. To elucidate this aspect we have performed a set of measurements with the purpose: first to identify a technique to easily detect the role of nucleation, second to compare the results obtained on poly and evaporated silicon films and to give a reasonable explanation of the results. In-situ resistance measurements is a candidate technique suitable to investigate the nucleation phenomenon. The main reason is because the various cobalt-silicon phases have quite different resistivity values: 110, 140 and 20 $\mu\Omega$ cm for Co$_2$Si, CoSi and CoSi$_2$ respectively.

II. EXPERIMENTAL

The 40 nm Co films were sputter deposited on 300 nm polysilicon film; to allow sheet resistance measurements the polysilicon film was on oxidized silicon wafer.

The annealings on 1x1 cm$^2$ samples cut from the whole wafer were made in a vacuum furnace at constant heating rate of 15°C/min; four point probe arrangement was used to measure the sheet resistance during the heating and cooling process. To identify the compounds responsible of the resistance variations samples were prepared by stopping the heating of as-prepared samples at pre-fixed temperatures. After the target temperature was reached, samples were cooled down with the maximum rate compatible with the experimental apparatus (characteristic cooling time …).

MeV $^4$He$^+$ Rutherford backscattering (RBS) and X-ray diffraction (XRD) techniques were employed to recognize and quantify the silicide phases present in all samples.

III. RESULTS AND DISCUSSION

The as-deposited cobalt film has a resistivity around 10-20 $\mu\Omega$ cm. In Fig. 1 are reported the in-situ sheet resistance data obtained by annealing sputter deposited Co film on 300 nm polysilicon, while in Fig. 2 and 3 are reported the corresponding XRD and RBS spectra after the annealing.

FIG. 1: In-situ resistivity measurements on sputter deposited Co on polysilicon. Dots mark the maximum annealing temperatures of the prepared samples.

FIG. 2: XRD spectra of sputter deposited Co on polysilicon after annealing at various temperatures.
The slight increase in resistance above 300 °C in Fig. 1 is not caused by a detectable Co-Si interaction and is probably due to contamination problems. The sharp increase above 420 °C is caused by the transformation of Co into Co$_2$Si, followed, at about 480 °C, by the formation of CoSi. The growth of CoSi ends around 500 °C and the flat region up to 600 °C is a clear signature of the presence of a nucleation barrier for the CoSi$_2$ phase formation.

Measurements at different heating rate and temperatures are in progress in order to quantify the incubation time and, may be, to get information on the nucleation barrier. At the same time we are preparing samples with evaporated cobalt and amorphous silicon in order to confirm the cited data on nucleation [2].

[2] G. Ottaviani, private communication. These results were recently confirmed by using a cobalt film deposited on amorphous silicon film.

**FIG. 3:** RBS spectra of sputter deposited Co on polysilicon after annealing at various temperatures.