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PRECIPITATE COLONIES IN SILICON

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PRECIPITATE COLONIES IN SILICON

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The following is a correction to a recent article by the authors[1] which report on the formation of dendritic shaped precipitate colonies in high purity silicon crystals. The individual precipitates in the colonies were tentatively identified as α-Fe_3Si by electron diffraction analysis. The cubic β-CuSi phase could also explain the electron diffraction pattern presented in ref. 1. However, the probability of copper precipitation was rejected because the concentration of copper in the heat treated specimens was measured as only 2×10^{15} atoms/cm^3.[2] This concentration corresponds to the solid solubility of copper in silicon at about 600°C,[3] whereas the precipitates were observed to form above 800°C.

A continued investigation by Nes and Lunde[4] of the impurity concentration and distribution in silicon single crystals of the same lopex silicon from Texas Instruments Company and also subjected to the same heat treatment, used in ref. 1, shows that the previous analysis for copper concentration was in error. More accurate values for copper concentration were obtained by a technique based on neutron activation.[4] The impurities were analyzed by gammaspectroscopy and at the same time autoradiographs of the silicon slices were taken by placing them in contact with a photographic

emulsion. The autoradiographs revealed an impurity distribution similar to the bulk distribution of precipitate colonies,[1] and by comparing the gamma spectra with the autoradiographs it was concluded that the colonies were a result of copper precipitation.[4]

The copper concentration of the as grown silicon single crystals has not been determined. However, some copper contamination during heat treatment seems almost unavoidable even though extreme care was exercised both during preparation and heat treatment of the specimens, as described in ref. 1. The diffusivity of copper in silicon at 800°C is very high,[3] 5×10^{-5} cm^2/sec., and a copper concentration of only about 3×10^{16} atoms/cm^3 is required to explain the observed density of precipitate colonies.

Thus the precipitate colonies were caused by a copper precipitation rather than the iron precipitation tentatively suggested in reference 1. Interpreted as copper precipitation, reference 1 represents a detailed investigation of the previously reported star-shaped clusters[5] and a clarification of the conditions under which they are formed in high purity, dislocation free, silicon single crystals.

REFERENCES

1. E. Nes and J. Washburn, J. Appl. Phys., 42, 3562 (1971).

2. E. Nes, Ph. D. Thesis, University of California (August 1970).

3. H. H. Woodbury and W. W. Tyler, Phys. Rev. 105, 84 (1957).

4. E. Nes and G. Lunde, to be published.

5. For a complete list of references on copper precipitation in silicon, see ref. 1.

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