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Influence of Boron and Germanium Doping on Physical-Mechanical Properties of Monocrystalline Silicon

Authors : Ia Kurashvili, Giorgi Darsavelidze, Giorgi Chubinidze, Marina Kadaria

Abstract : Boron-doped Czochralski (CZ) silicon of p-type, widely used in the photovoltaic industry is suffering from the light-induced-degradation (LID) of bulk electrophysical characteristics. This is caused by specific metastable B-O defects, which are characterized by strong recombination activity. In this regard, it is actual to suppress B-O defects in CZ silicon. One of the methods is doping of silicon by different isovalent elements (Ge, C, Sn). The present work deals with the investigations of the influence of germanium doping on the internal friction and shear modulus amplitude dependences in the temperature interval of 600-800^{0}C and 0.5-5 Hz frequency range in boron-containing monocrystalline silicon. Experimental specimens were grown by Czochralski method (CZ) in [111] direction. Four different specimens were investigated: Si+0,5at%Ge:B (5.1015cm-3), Si+0,5at%Ge:B (1.1019cm-3), Si+2at%Ge:B (5.1015cm-3) and Si+2at%Ge:B (1.1019cm-3). Increasing tendency of dislocation density and inhomogeneous distribution in silicon crystals with high content of boron and germanium were revealed by metallographic studies on the optical microscope of NMM-80RF/TRF. Weak increase of current carriers-holes concentration and slight decrease of their mobility were observed by Van der Pauw method on Ecopia HMS-3000 device. Non-monotonous changes of dislocation origin defects mobility and microplastic deformation characteristics influenced by measuring temperatures and boron and germanium concentrations were revealed. Possible mechanisms of changes of mechanical characteristics in Si-Ge experimental specimens were discussed.

Keywords : dislocation, internal friction, microplastic deformation, shear modulus
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