INFLUENCE THE HEAT TREATMENT ON THE MECHANICAL CHARACTERISTICS OF SILICON PLATES

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The paper is devoted to research of influence the heat treatment of silicon plates on their mechanical characteristics. Silicon plates n- and p-type conductivity having diameter of 100 mm are investigated. Plates had surface orientations of (111).

1. Introduction

During the fabrication of integrated circuits and other semiconductor devices, silicon wafers are exposed to various mechanical and thermal processes. As a result, there is a big danger of dislocation generation in these wafers and deterioration of semiconductor devices characteristics. Therefore, the questions connected with the problem of dislocation generation in semiconductor materials in a wide temperature interval, still remain topical and need to be further investigated.

There are many articles that are devoted to dislocation generation under the action of various external factors

[1-3]. According to our and other articles [1,4], dislocation movement under loading has a spasmodic character.

By using the investigation methods of microhardness and fracture toughness, much valuable information can be obtained about the mechanical proprieties of semiconductor materials in a wide range of temperatures.

2. Experimental methods

Investigations were carried out on both n- and p-type silicon wafers having diameters of 76 and 100mm with (111)-1 and (100)-2 surface orientations. Microhardness H, fracture toughness K and the imprint length d were used as the characteristic parameters (Fig.1,2,3).

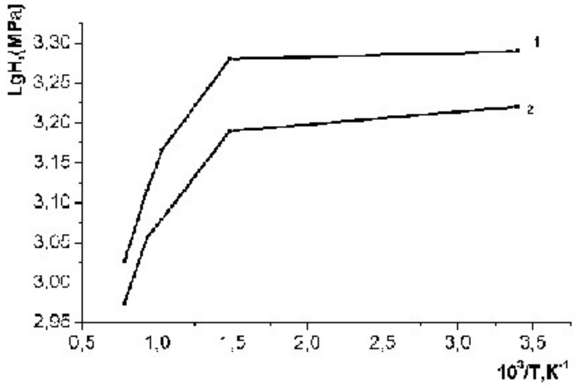

Fig.1

At least 20 tests for each sample were carried out for determination of the microhardness. The microhardness measurements were accomplished by a PMT-3 type device. . The fracture toughness was determined on the same imprints as used for microhardness. The investigated samples were heat treated in the atmosphere. For heating each wafer uniformly and avoiding it from direct heat radiation, it was covered with another wafer. The loads applied on the Vickers pyramid were varied in the range 0.3-1.2 N.

The calculations of the microhardness and the fracture toughness values were done using [5].

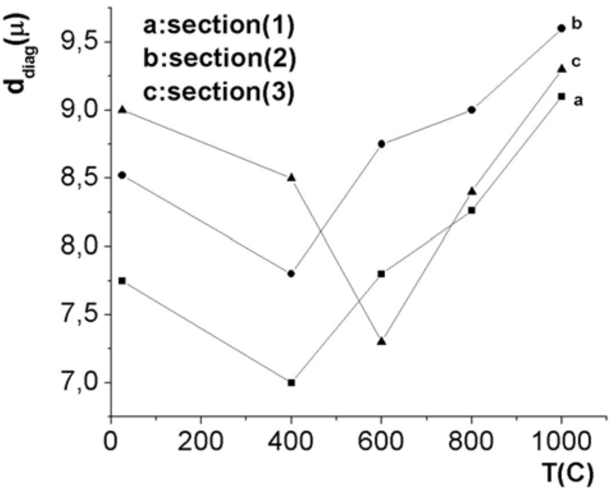

Fig.2.

The experiments were carried out at room temperature.

Microhardness and diagonal length of the replica channel have been used as characteristic parameters. Microhardness has been determined by results of not less than 20 tests for each sample by means of device PMT-3.

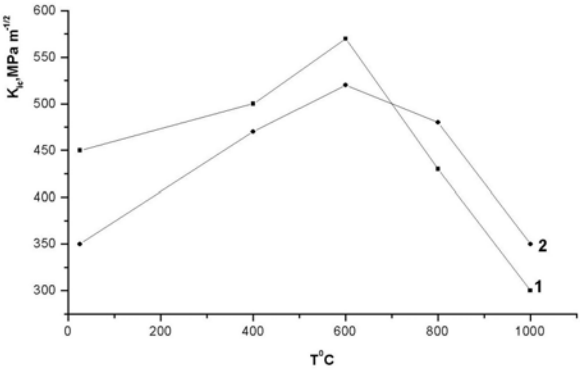

*Fig.*3

The Vickers pyramid has been used as indenter. Heat treatment of the investigated samples has been carried out in an air atmosphere. Loading on pyramids (at indenting) is varied from 0.3 up to 1.2 N.

The following experimental results are obtained.

1.Dependence of microhardness on annealing temperature has the exponential character, namely, with reduction of annealing temperature the microhardness value sharply grows and further reaches the monotonous growth (Fig.1).

2. With growth of annealing temperature up to T~450^{0}C diagonal length of the replica channel decreases,at the further growth of annealing temperature it sharply increases. Moreover, at T=250C and T=1000^{0}C diagonal length of the replica channel at the edges of plates is more than in the middle of plates (Fig.2).

3. The non-uniform distribution of fracture toughness on the surface of wafers depends on the loading. On the edges of wafers K value is less than that on the middle of wafers. At the increasing of the annealing temperature (at constant F values) the value of K increases reaching the maximum value and it sharply decreases at temperatures above 800^{0}C.

3. Conclusions

1. The occurrence of dislocations at low temperatures area (where the thermal activation is practically absent) means that during the local indentation of the sample surface, stresses larger than the Pairel`s stress can be created.

2. The temperature dependences of the microhardness and dislocations and sliding strips running from the imprint after annealing process confirm again the relaxation possibilities of elastic stress at the room temperatures.

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TERMOİŞLƏMƏLƏRİN SİLİSİUM LÖVHƏLƏRİNİN MEXANİKİ XÜSUSİYYƏTLƏRİNƏ TƏSİRİ

İş, diametri 100 mm olan, n və p tip keçiriciliyə malik, (111) orientasiyalı silisium lövhələrinin mikromöhkəmlik, çat əmələgəlməyə dözümlülük və s. mexaniki xüsusiyyətlərinə termoişləmələrin təsirinin tədqiqinə həsr olunmuşdur.Göstərilmişdir ki, termoişləmələr zamanı mexaniki xassələrin dəyişməsinə səbəb dislokasiyaların hərəkəti və mexaniki gərginliklərin relaksasiyalarıdır.

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ВЛИЯНИЕ ТЕРМИЧЕСКОЙ ОБРАБОТКИ НА МЕХАНИЧЕСКИЕ ХАРАКТЕРИСТИКИ КРЕМНИЕВЫХ ПЛАСТИН

Работа посвящена исследованию влияния термической обработки кремниевых пластин n- и p- типа проводимости диаметром 100 мм и с ориентацией (111) на механические характеристики: микротвердость, трещиностойкость и др. Показано, что изменения механических характеристик при термической обработке обусловлены движением дислокаций и релаксацией механических напряжений.

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