



Designation: F 1212 – 89 (Reapproved 1996)^{ε1}

Standard Test Method for Thermal Stability Testing of Gallium Arsenide Wafers¹

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^{ε1} NOTE—Keywords were added editorially in February 1997.

1. Scope

1.1 This destructive test method determines whether a given sample of semi-insulating gallium arsenide (GaAs) will remain semi-insulating after exposure to the high temperatures normally required for the activation of implanted layers.

1.2 The underlying assumption is that other wafers of GaAs, whose manufacturing history was the same as the wafer from which the test sample was taken, will respond to high temperatures in like manner.

1.3 The emphasis in this test method is on simplicity and safety of apparatus, and on securing a measurement that is independent of the apparatus used.

1.4 This test method is directly applicable to uncapped and unimplanted samples of GaAs. However, users of this test method may extend it to capped or implanted samples, or both, in which case a controlled test of capped versus uncapped samples, or implanted versus unimplanted samples, is recommended.

1.5 This test method detects impurities “from the bulk” (that is, from within the GaAs wafer) that will likely affect the electrical behavior of devices formed on the surface of the wafer. This test method is not sensitive to surface impurities or process-induced impurities, except as interferences (see Interferences).

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

F 76 Test Methods for Measuring Resistivity and Hall Coefficient and Determining Hall Mobility in Single-Crystal Semiconductors²

3. Terminology

3.1 Definitions:

¹ This test method is under the jurisdiction of ASTM Committee F-1 on Electronics and is the direct responsibility of Subcommittee F01.15 on Gallium Arsenide.

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² *Annual Book of ASTM Standards*, Vol 10.05.

3.1.1 *annealing*—The process of heating a sample of GaAs in a furnace to a specific temperature, under a reducing atmosphere and with a means to reduce the loss of arsenic via sublimation from its surface.

3.1.2 *capped annealing*—The process of placing a protective layer (usually silicon nitride or silicon dioxide) on the GaAs sample surface, thereby reducing the loss of arsenic vapor from the sample’s surface during annealing. It is not described further in this test method, since the capping process introduces several variables that can affect the test results.

3.1.3 *proximity annealing*—The process of placing the GaAs sample between two similar pieces of GaAs, thereby reducing the loss of arsenic vapor from the sample’s surface during annealing.

3.1.4 *thermal stability*—The ratio between the sample’s apparent bulk resistivity after the annealing test, and an identical sample’s bulk resistivity without annealing.

4. Summary of Test Method

4.1 The sample is heated in a manner similar to the heating process that an ion-implanted wafer would undergo. Then the bulk resistivity of the sample is compared to the bulk resistivity of an identical sample (control) that did not undergo heat treatment. The difference between the resistivities, if any, is a measure of the sample’s sensitivity to heat treatment, or in other words its “thermal stability”.

5. Significance and Use

5.1 Devices that involve ion implantation into a monocrystalline semi-insulating GaAs wafer are designed with the assumption that the wafer will remain semi-insulating during manufacture. However, ion implantation always damages the crystal lattice of the wafer’s surface, and the damaged surface layer tends to collect impurities from the bulk of the wafer when the wafer is heated. Those impurities can become unwanted dopants: they can render the surface layer conductive, or interfere with the implanted species in various ways. The net effect in either case is a nonfunctioning device.

5.2 No spectroscopic method is sensitive enough to detect all possible bulk impurities; their presence in the wafer itself cannot be predicted in advance. This test method serves to concentrate them in the surface layer of a sample taken from one of the wafers, so that a semiquantitative estimate of their electrical behavior may be made.