Flat Punch vs Spherical Indenter Probe for Fracture Testing of GaAs Single Crystals Used in Microelectronics and Semiconductor Industry

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Abstract

The increasing demand for microelectronics necessitates standardized materials testing techniques at small length scales. While advancements have been made in material testing at the micro-scale, there are still gaps to be addressed, partly due to the complexities involved, such as specimen manufacturing, indenter probe misalignment, and crack length definition. Various nanoindentation methodologies, including the utilization of flat punch (wedge) or spherical probes, are available; yet the clarification of how the shape of the indenter probe impacts the stress intensity factor in GaAs remains obscure. A flat punch is suitable for modes I and II loading conditions, providing a proper contact line, while a spherical probe is preferable for mode III loading conditions. Another critical challenge in testing micro-scale materials is the alignment of the indenter probe. A 1° misalignment of a flat punch indenter probe resulted in a ±18.8% and a ±16.4% error in stress intensity factor for mode II and III loading conditions, respectively.

Objective

The proposed research aims to delineate variances between flat punch and spherical indenter probes in nanoindentation methodology applied to GaAs. The objective is to enhance stress intensity factor accuracy, establishing a standardized nanoindentation approach for diverse loading conditions. Additionally, the study seeks insights into mitigating critical errors arising from indenter probe misalignment.

Fracture Modes And Indenter Probe Options

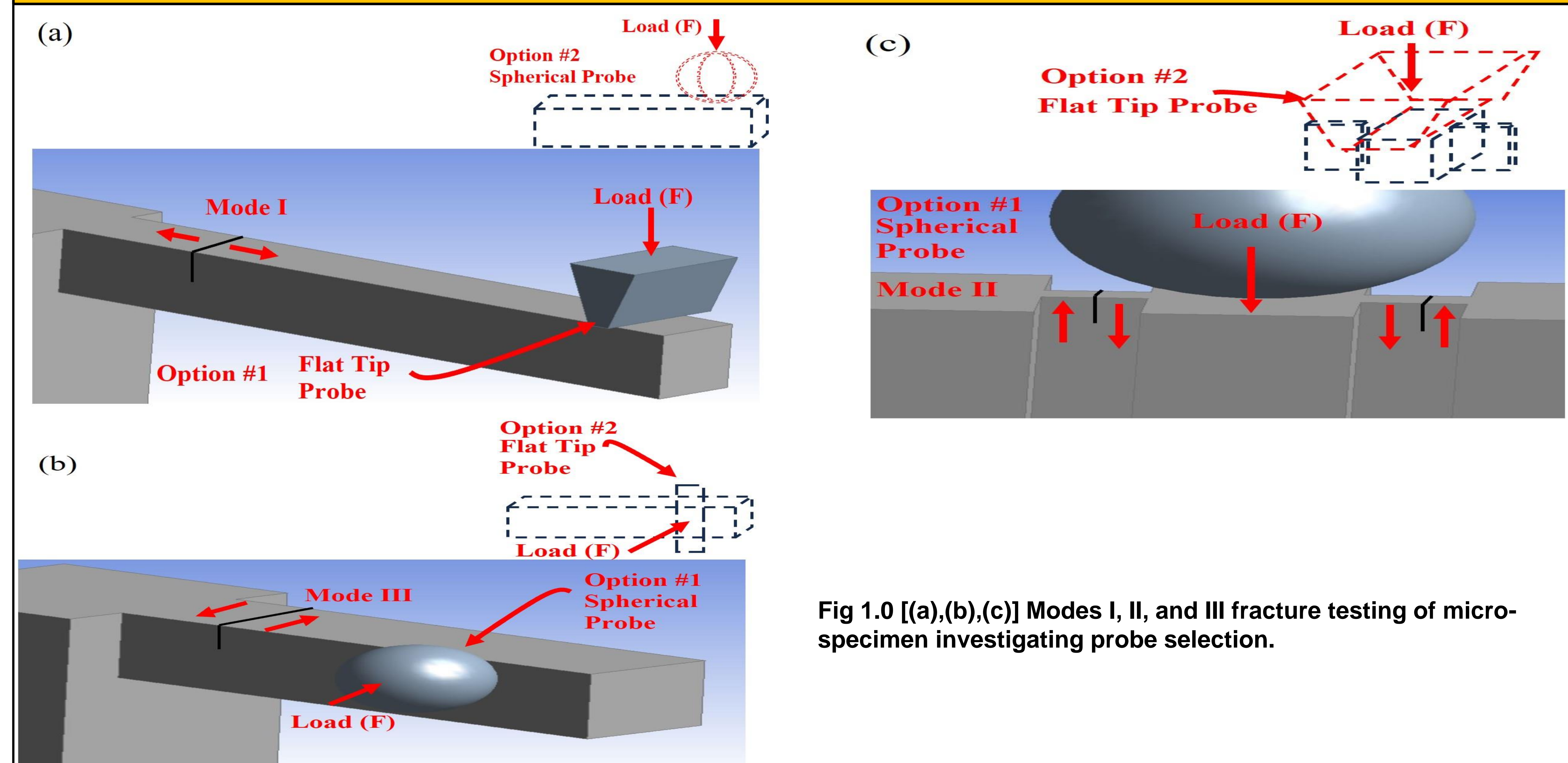
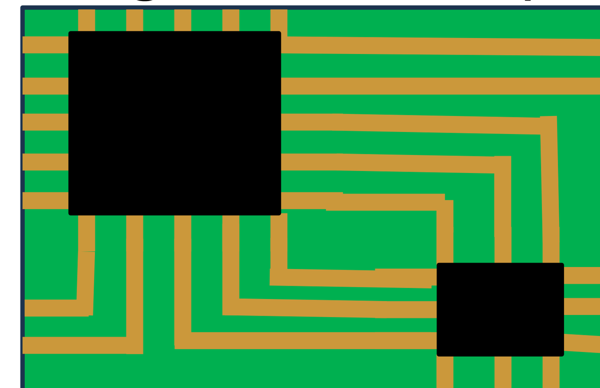


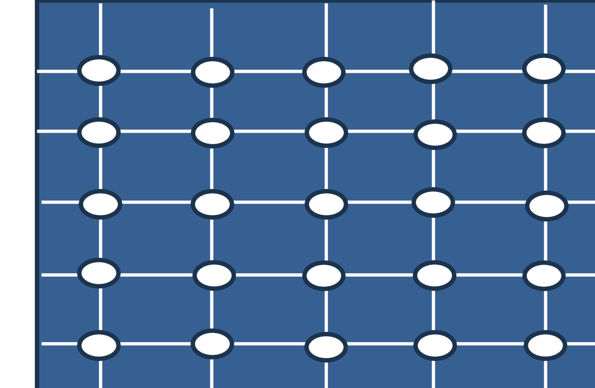
Fig 1.0 [(a),(b),(c)] Modes I, II, and III fracture testing of micro-specimen investigating probe selection.

Gallium Arsenide Applications

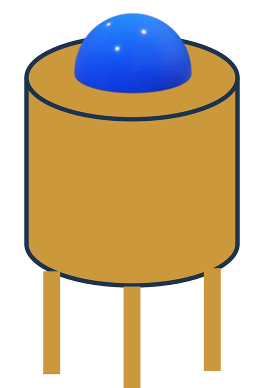
Integrated Circuits (ICs)



Solar Panels



Laser Diodes



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