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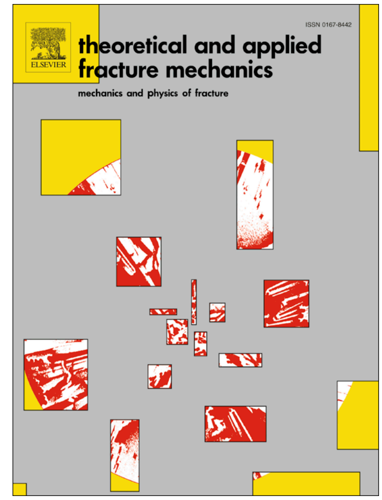

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Static assessment of nanoscale notched silicon beams using the averaged strain energy density method

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Abstract

This paper extends the averaged Strain Energy Density (SED) method to the static assessment of notched components at the nanoscale. First, *in situ* micromechanical testing of notched nano-cantilever beams made of single-crystal silicon is briefly reviewed. Then, an alternative strategy based on the Theory of Critical Distances is employed to evaluate the SED control volume and the critical SED. The method is later verified against experiments and FE analyses. The SED method successfully estimates the load at fracture of nanoscale notched specimens with a maximum discrepancy of 4.7%. Moreover, the method is mesh-independent, and therefore very coarse meshes can be employed in numerical analyses. Finally, the results are discussed on the basis of the breakdown of continuum fracture mechanics at the nanoscale. The extension of the SED approach to the micro- and nanoscales provides a fast and simple tool for the design of micro- and nanodevices.

Keywords: nanoscale; single-crystal silicon; theory of critical distances; strain energy density; fracture nanomechanics.

1. Introduction

The miniaturisation of electronic devices, for example, the use of micro- and nano-electromechanical systems (MEMS and NEMS) as sensors and actuators, have brought problems of material behaviour at the nanometer scale into the domain of fracture mechanics [1]. Thus, new