报告题目： **三维功能梯度材料裂纹与位错间相互作用的理论分析框架**

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摘要：裂纹与位错间的相互作用是固体力学和材料科学领域十分重要的基础问题之一。由于数学分析上的困难性，过去关于解析求解这类问题的研究大多局限于均匀材料中的二维问题。 然而，真实的裂纹和位错的尺寸都是有限的。另一方面，真实的材料本质上是三维的且通常会被制备成非均匀材料，如功能梯度材料(FGMs)等。因此，理解裂纹与位错间在非均匀材料中的相互作用机制具有重要的科学价值和实际意义。该项研究旨在发展一套有效求解三维功能梯度材料中裂纹与位错间相互作用的理论分析框架。与已有的分析方法相比，该理论框架具有以下几点优势：(1)能够考虑 FGMs 中任意变化的弹性模量和泊松比；(2)具有较高的计算效率、稳定性和精度；(3)可以统一地获得一大类均匀材料中裂纹与位错间的相互作用的闭合解。本次研讨会将着重介绍我们近期在 FGMs 位错理论上取得的成果，以及其在 FGMs 中币形裂纹与位错间相互作用轴对称问题的应用。最后，我们还将简要介绍该方法论在岩土工程和力学中的应用。

Theoretical Framework for Crack and Dislocation Interaction in 3D FGMs

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Abstract: Crack-dislocation interaction is one of the most fundamental problems in solid mechanics and material science. Previous analytical treatments have been mostly limited to plane problems in homogeneous material domain due to the intrinsic mathematical difficulty (Anderson and Rice 1987, JMPS; Gao,1989, JMPS; Gao and Rice,1989, JMPS; Gao,1991, JMPS). However, real cracks and dislocations are in finite size. Additionally, real material domain is essentially in 3-D nature and can be engineered to be highly inhomogeneous, such as functionally graded materials (FGMs). Understanding the interaction behavior in 3-D inhomogeneous material domain is thus of both scientific interest and practical importance. In this research, we aim to develop an efficient theoretical framework for the analysis of crack-dislocation interaction in 3-D FGMs. Unlike most exiting treatments on crack problems in FGMs, in this framework both the shear modulus and the Poisson's ratio of FGMs are allowed to vary in arbitrary manner. Another advantage of this framework is that it can use huge number of homogenous sublayers to approximate the FGMs without the loss of computational efficiency, stability and accuracy. Additionally, it is also featured by its mathematical consistency in that a group of closed form solutions to the interaction problems with special geometry in homogenous material can also be obtained in a unified manner. In this talk, we will focus on our recent progress in the solution of dislocation in FGMs and its application to the axisymmetric interaction between a penny-shaped crack and dislocations near an arbitrarily graded interface. At the end of this talk, the application of this framework to the analysis of some important problems in geomechanics will be also discussed.

Key references:

[1] Chen X W, Yue Z Q. (2021). A unified mathematical treatment of interfacial edge dislocations in three-dimensional functionally graded materials[J]. Journal of the Mechanics and Physics of Solids, 104471.

[2] Chen X W, Yue Z Q.(2022). Mathematical modelling approach for axisymmetric interaction between a penny-shaped crack and dislocations near an arbitrarily graded interface (to be submitted).