Anisotropy

Introducing

Description

Chapter 1: tensors
- Definition of tensor (use, order, transformation rules)
- Writing tensor relations: classical mathematical notation, Einstein convention, matrix notation.
- Tensors and symmetries (symmetric tensors, invariances and symmetries of the system)

Chapter 2: tensors and mechanical properties
- Definition of stress, strain, elasticity and rigidity tensors.
- The different types of stress/deformation (traction, shear).
- Voigt/engineer notation (6-component notation).
- Isotropic elasticity tensor
- Physical constants of isotropic elasticity (Young, Poisson, Coulomb moduli and Lamé coefficients).

Chapter 3: static couplings
- Direct and inverse piezoelectricity
- The piezoelectric tensor.
- The acousto-optic effect
- Couplings between static properties: general concepts and definition of effects (pyroelectricity, thermal expansion, etc.).
- Statistical theory of couplings and matrix representation (Voigt notation).
- Primary and secondary effects (e.g. primary and secondary pyroelectricity)

Chapter 4: anisotropic optics
- The representation of a tensor of order 2: the ellipsoid of indices and its geometric interpretation.
- Permittivity tensors and optical indices.
- Optical propagation along one of the main axes of an anisotropic system and the retarders (quarter-wave and half-wave blades).
- Optical propagation in any direction in an anisotropic system: birefringence and beam-splitters.

Objectives

Learn the fundamental ideas behind tensor theory and operation, as well as how they can be applied to characterize the anisotropic properties of crystals. A number of applications will be discussed in relation to anisotropic optics (wave plates, birefringence, etc.) and couplings (piezoelectricity, acousto-optic effect, etc.).

Necessary prerequisites

Linear algebra, mathematical analysis of functions with several variables, solid mechanics, wave optics.

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Toulouse