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Static response of functionally graded multilayered one-dimensional hexagonal piezoelectric quasicrystal plates using the state vector approach

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Key words: State vector approach, Functionally graded, Piezoelectric quasicrystals, Plates

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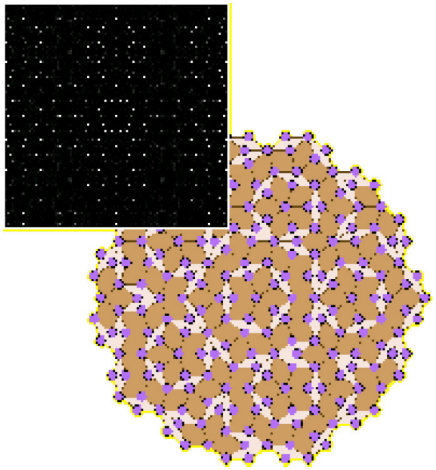
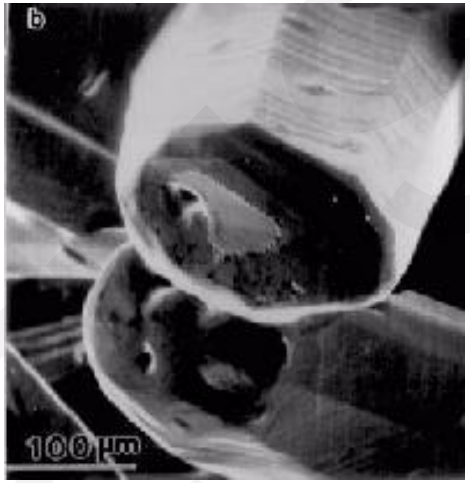
INTRODUCTION

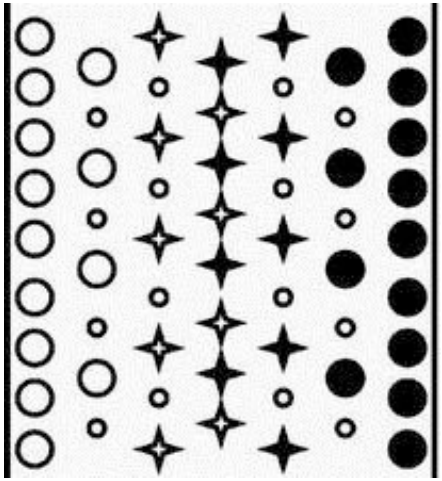
Discovery → Development → Application



(a) Penta-rotating symmetry



(b) Quasicrystal
Example: Al_{70} Ni_{15} Co_{15}

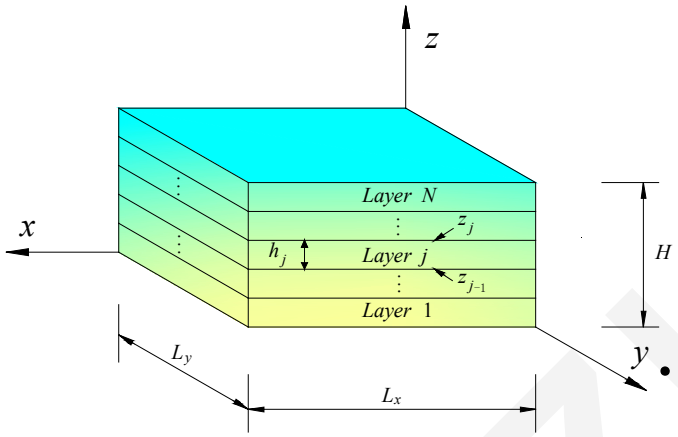


(c) Functionally graded quasicrystals

Research process of quasicrystals

Shechtman et al, Phys. Rev. Lett., 1984; Fan, Science Press. 2011

METHOD



Multilayered piezoelectric quasicrystal plates

State equations based on the major equations of mechanics

$$\frac{\partial \boldsymbol{\theta}}{\partial z} = \mathbf{K}\boldsymbol{\theta}$$

Integrating equation

$$\boldsymbol{\theta}(z) = exp[\mathbf{K}(z - z_{j-1})]\boldsymbol{\theta}(z_{j-1})$$
$$= \mathbf{Q}(z - z_{j-1})\boldsymbol{\theta}(z_{j-1})$$

Propagator matrix method

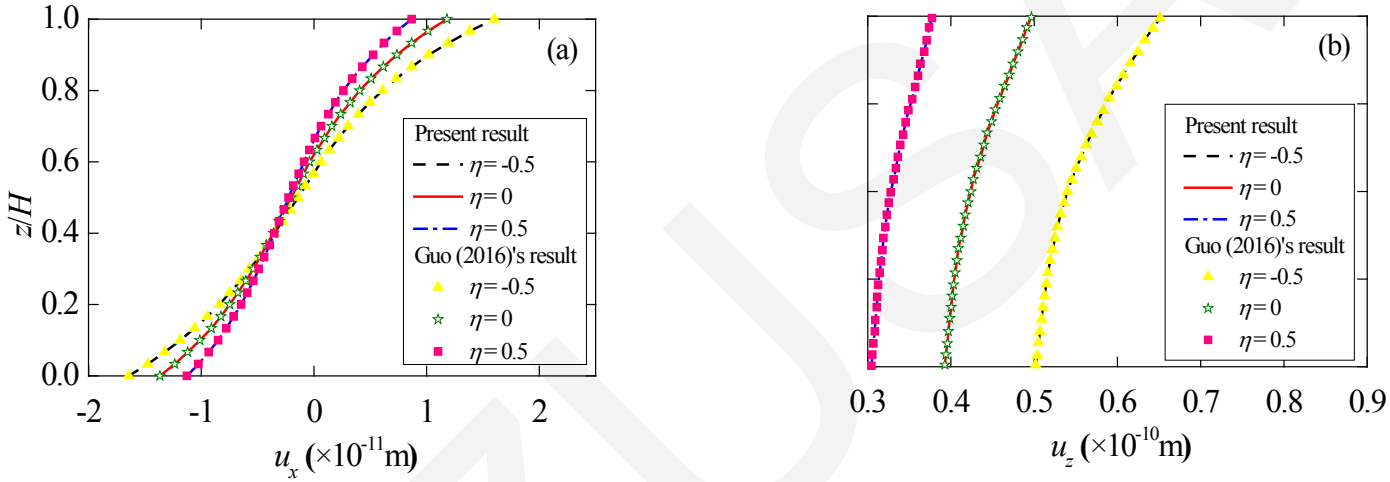
$$\boldsymbol{\theta}(z_N) = \mathbf{Q}_N \mathbf{Q}_{N-1} \ldots \mathbf{Q}_1 \boldsymbol{\theta}(0)$$

The quasi-periodic direction is ***z*** direction

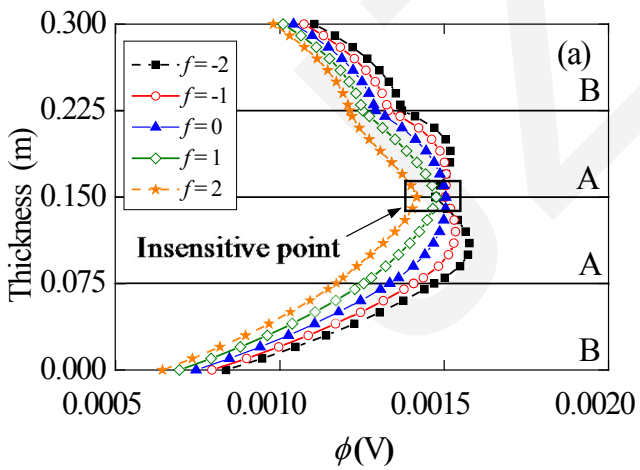
Fan, Eng., 2013; Li et al, Act. Mech., 2017

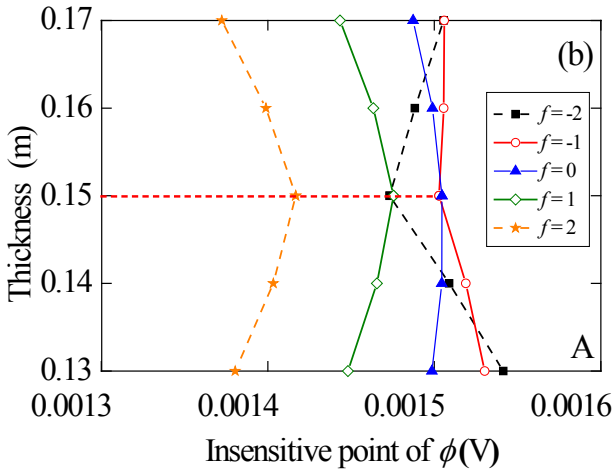
RESULTS

The results at the (x, y) = ($0.75L_x$, $0.75L_y$) under the load of phonon stress



Effect of graded factor on phonon displacement





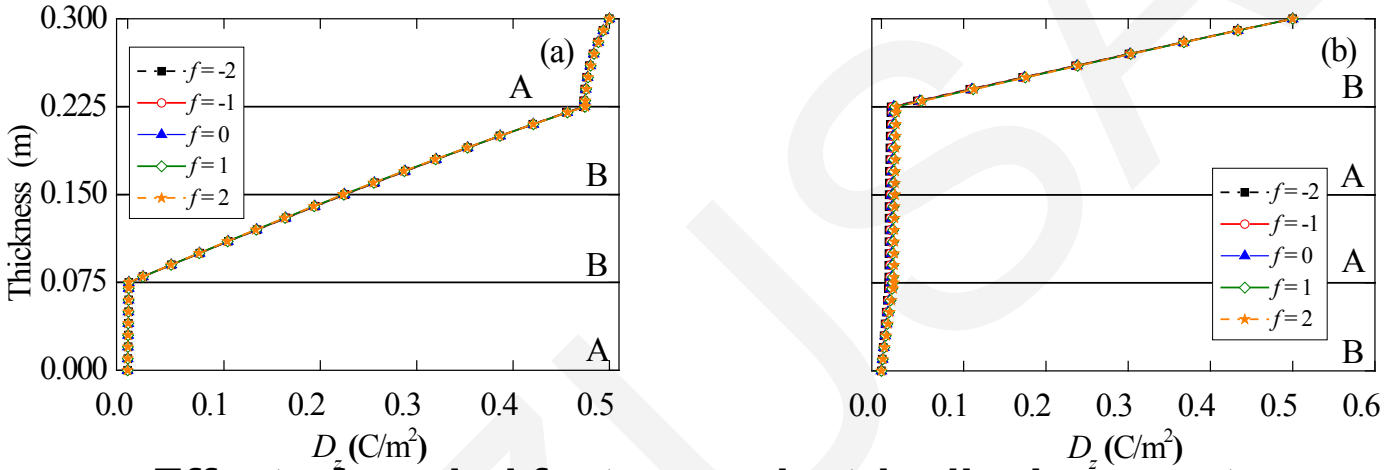
[L1]

Guo et al, Int. J. Eng. Sci., 2016

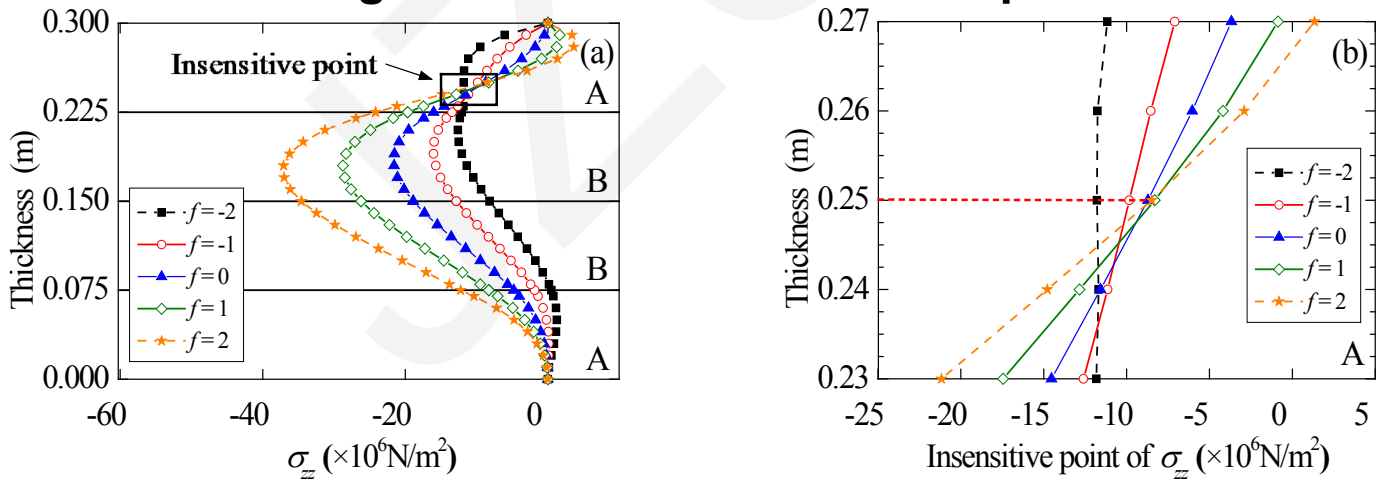
Insensitive point of electric potential

RESULTS

The results at the same position under the load of electric displacement



Effect of graded factor on electric displacement



Insensitive point of phonon stress

[L1]

CONCLUSION AND PROSPECT

- The static response of functionally graded piezoelectric quasicrystal plates is firstly analyzed by the state vector approach.
- The effects of stacking sequence and two varying functions of material gradient are investigated.
- The state vector approach can be extended to investigate other non-homogeneous materials and quasicrystal structures.
- The numerical calculations of static response of quasicrystal plates are of important values for guiding engineering design and construction.