Asymptotic modeling of non-linear viscopiezoelectric Kelvin-Voigt type plates via Trotter theory

THIBAUT WELLER, CHRISTIAN LICHT, SOMSAK ORANKITJAROEN, YOTSAWAT TERAPABKAJORNDED

ABSTRACT. We investigate the asymptotic behavior of the dynamic response of a thin viscopiezoelectric plate as its thickness, taken as a parameter, approaches zero. We use Trotter theory of convergence of semi-groups of operators acting on variable spaces. Depending on the kind of electrical loading and on the orders of magnitude of the density and of the viscosity, we highlight four different sensor and actuator behaviors.

REFERENCES

[1] Bachmar, A.; Boutechebak, S.; Serrar, T. Variational analysis of a dynamic electroviscoelastic problem with friction, *Zh. Sib. Fed. Univ. Mat. Fiz.* **12** (2019), no. 1, 68–78.

[2] Barboteu, M.; Fernández, J. R.; Ouafik, Y. Numerical analysis of a frictionless viscoelastic piezoelectric contact problem, *M2AN Math. Model. Numer. Anal.* **42** (2008), no. 4, 667–682.

[3] Behera, S. K.; Kumar, D. ; Sarangi, S. Modeling of electro–viscoelastic dielectric elastomer: A continuum mechanics approach, *Eur. J. Mech. A Solids* **90** (2021), Paper no. 104369, 7 pp.

[4] Brezis, H. *Opérateurs maximaux monotones et semi-groupes de contractions dans les espaces de Hilbert*. North-Holland, Amsterdam, 1973.

[5] Ciarlet, P.G. *Mathematical Elasticity, Vol. II: Theory of Plates*. North-Holland, Amsterdam, 1997.

[6] Dilmi, M.; Dilmi, M.; Benseridi, H. Asymptotic analysis of quasistatic electro-viscoelastic problem with Tresca's friction Law, *Comput. Math. Methods* **1** (2019), no. 3, e1028, 15 pp.

[7] Erofeev, V. I.; Pavlov, I. S. *Structural Modeling of Metamaterials. Advanced Structured Materials*, 144. Springer, Cham, Switzerland, 2021.

[8] Gaudiello, A.; Monneau, R.; Mossino, J.; Murat, F.; Sili, A. Junction of elastic plates and beams, *ESAIM Control Optim. Calc. Var.* **13** (2007), no. 3, 419–457.

[9] Iosifescu, O.; Licht, C.; Michaille, G. Nonlinear boundary conditions in Kirchhoff-Love plate theory, *J. Elasticity* **96** (2009), no. 1, 57–79.

[10] Iosifescu, O.; Licht, C. Transient response of a thin linearly elastic plate with Norton or Tresca friction, *Asymptot. Anal.* **128** (2022), no. 4, 555–570.

[11] Lerguet, Z.; Shillor, M.; Sofonea, M. A frictional contact problem for an electro-viscoelastic body, *Electron. J. Differential Equations* (2007), no. 170, 16 pp.

[12] Licht, C. Thin linearly viscoelastic Kelvin-Voigt plates, *C. R. Mecanique* **341** (2013), no. 9-10, 697–700.

[13] Licht, C.; Weller, T. Approximation of semi-groups in the sense of Trotter and asymptotic mathematical modeling, *Discrete Contin. Dyn. Syst. Ser. S* **12** (2019), no. 6, 1709–1741.

[14] Licht, C.; Orankitjaroen, S.; Weller, T. Asymptotic analysis of the transient response of a thermoelastic assembly involving a thin layer, *C. R. Mecanique* **350** (2022), 27–45.

[15] Terapabkajorned, Y.; Orankitjaroen, S.; Licht, C. Asymptotic model of linearly viscoelastic Kelvin-Voigt type plates via Trotter theory, *Adv. Difference Equ.* (2019), Paper no. 186, 9 pp.

[16] Terapabkajorned, Y.; Orankitjaroen, S.; Licht, C.; Weller, T. Asymptotic modeling of the transient response of non-linear Kelvin-Voigt viscoelastic thin plates with Norton or Tresca friction by Trotter theory, *Appl. Math.* **69** (2024), no. 1, 25–48.

[17] Terapabkajorned, Y.; Orankitjaroen, S.; Licht, C.; Weller, T. Asymptotic modeling of thin plates and slender beams, a unifying approach, *C. R. Mecanique* **352** (2024), 201–222.

[18] Trotter, H. F. Approximation of semi-groups of operators, *Pacific J. Math.* **8** (1958), 887–919.

[19] Weller, T.; Licht, C. Asymptotic modeling of thin piezoelectric plates, *Ann. Solid Struct. Mech.* **1** (2010), 173–188.

LMGC, UNIVERSITÉ DE MONTPELLIER
CNRS, MONTPELLIER
FRANCE
Email address: christian.licht@umontpellier.fr, thibaut.weller@umontpellier.fr

CENTER OF EXCELLENCE IN MATHEMATICS
CHE, BANGKOK 10400, THAILAND
Email address: christian.licht@umontpellier.fr, somsak.ora@mahidol.ac.th

Department of Mathematics
Faculty of Science
Mahidol University, Bangkok 10400, Thailand
Email address: christian.licht@umontpellier.fr, somsak.ora@mahidol.ac.th, ongyosawat@gmail.com