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MONOTONE DIFFERENCE SCHEME FOR ENERGY FLUX CONTINUITY EQUATION IN SEMICONDUCTORS

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Quasi-hydrodynamic approach is more and more widely used to describe energy flux kinetics in semiconductors [1]. Here a generalized flux approach is applied to construct monotone difference scheme for energy flux density continuity equation:

$$\frac{\partial}{\partial t}\epsilon + \frac{\partial}{\partial x} I = P. \tag{1}$$

Energy balance equation (1) is written as advection-diffusion equation by introducing such generalized energy flux density:

$$I = -\frac{2}{3} C\mu T \frac{\partial}{\partial x}\epsilon + \frac{2}{3} C \left(\mu \frac{\partial \varphi}{\partial x} - \frac{\partial}{\partial x}(\mu T)\right)\epsilon - 2C\mu p T \frac{\partial}{\partial x}\varphi + \frac{2}{3}\int_{x_0}^{x} dx v \frac{\partial}{\partial x}\epsilon, \tag{2}$$

with a non-linear velocity:

$$v = \frac{3}{2}\frac{\partial}{\partial x}\varphi \left(\frac{\partial}{\partial x}\epsilon\right)^{-1} \left(\frac{2}{3}\epsilon \frac{\partial}{\partial x}\mu - \mu N \frac{\partial}{\partial x}\varphi + \frac{\partial}{\partial x}(2pT)\right) + \mu \frac{\partial}{\partial x}\varphi. \tag{3}$$

For such advection-diffusion type equation energy density ϵ (temperature T) must be positive due to physical requirements. Monotonicity itself (maximal principle conditions) is satisfied by using exponential difference scheme approach [2]. In general, previous energy balance equation schemes have only rarely had this feature. Proposed scheme is unconditionally monotone, has the first order truncation error in time and second order truncation error in space in the case of small electric field (small advective term with velocity v), and the first order truncation errors for the advective dominated transport.

REFERENCES

[1] R.V.N. Melnik and H. He. Modelling nonlocal processes in semiconductor devices with exponential difference schemes. *J. Engrg. Math.*, **38** (3), 2000, 233 – 263.

[2] J. Rimshans. Half-implicit difference scheme for advection-diffusion equation. In: *Proc. of the 12th Conference of the European Consortium for Mathematics in Industry, Jurmala, Latvia, 2002*, Abstracts, 2002, 61–62.