Modelling Mechanoluminescence in $BaSi_2O_2N_2$: Eu^{2+}

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$BaSi_2O_2N_2:Eu^{2+}$ is a mechanoluminescent (ML) phosphor that shows high sensitivity to dynamic loads[1, 2]. Our tensile tests show that the ML intensity is independent of prior stress and its spatial distribution agrees well with the Von Mises strain. However, the magnitude of ML intensity, total ML energy and ML decay time depend on the strain rate and loading manner. Based on these experimental facts, the irreversible deformation induced by an asymmetric stress tensor during dynamic loading was introduced as the driving force of ML. It was treated as an internal variable in the framework of non-equilibrium thermodynamics, and confirmed the basic characteristics of ML. On the other hand, the dynamics of luminescence under the assumption that dynamic stress induces a change of trap depth or causes excess population of electrons was modelled by reaction rate equations and Monte Carlo simulation. The nonlinear dependence on strain rate and plateau effects near maximal strain during loading can be predicted form the model. It seems possible to bridge the gap between mechanics and luminescence using modelling in the study of mechanoluminescence.

Reference:

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