Mechanoluminescence in a transparent glass composite

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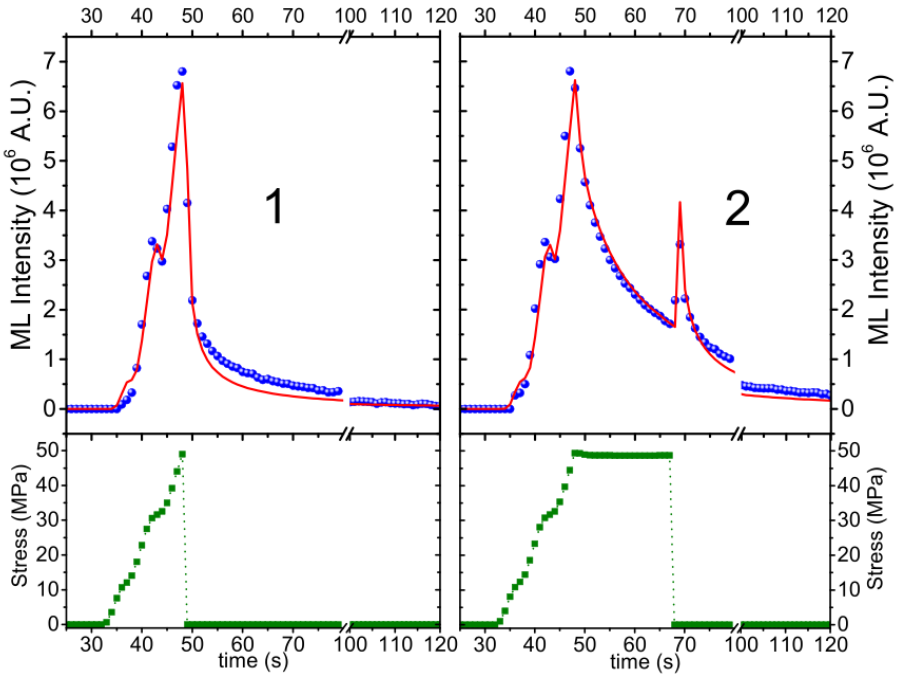
Mechanoluminescence (ML) is the phenomenon of light emission during a mechanical loading. The phenomenon is known since a long time (in sugar, since the 17th century at least). Many materials have been developed to produce elastico-luminescence (light emission during pure elastic deformation). We have developed glass composites with elastico-luminescent particles, namely $SrAl_2O_4$:Eu,Dy crystal, in order to obtain "smart glasses", able to provide information on the stress they undergo, before they break.

Because the light emission occurs during reversible deformation in this material, it allows for the development of load sensors: the light emission is reproducible and repeatable. Nevertheless, there is still a lack of efficient and simple model to establish the relationship between the stress applied on a material and the light it emits, especially for complex loading histories. We present here a model of mechanoluminescence. We highlight, through this model, that the intensity of the light emission is not connected to the current stress, but to the whole history of stress from the beginning of the loading. We also take into account the limited light emission in elastico-luminescent materials.



On the top: ML intensity recorded (blue circles) for two different mechanical loading histories on the glass composite, and their fitting by the model (red lines). On the bottom, the corresponding mechanical loading histories.