Development of a strain sensor using mechanoluminescence for multiaxial stress measurement

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Mechanoluminescence refers to the phenomenon in which a material emits light in response to externally applied strain [1][2]. The aim of this study is to develop a multiaxial stress sensor capable of identifying the loading direction applied to mechanical components by using a mechanoluminescent material. To achieve this purpose, we focused on the stress concentration generated around circular holes. In this study, a circular plate with multiple holes was fabricated using a stereolithography 3D printer, and a sensor prototype was produced by coating its surface with mechanoluminescent paint (see Fig. 1). Tensile loads were applied from various directions, and the resulting luminescence intensity was quantified. The results demonstrated that the desired sensing characteristics can be achieved using a disk-shaped structure containing multiple circular holes. Furthermore, we developed an image analysis technique based on the commercial finite element software Marc Mentat 2023 (MSC Software Corporation). Simulation results confirmed that this method can successfully identify both the direction and magnitude of the applied load.

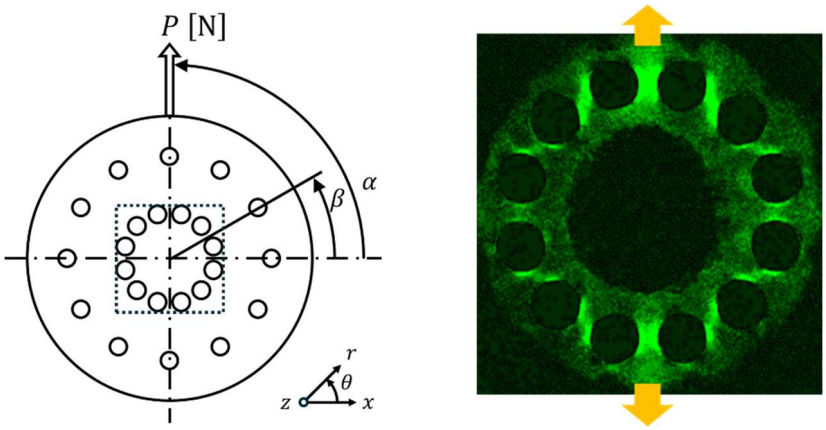

Figure 1. Proposed model (left) and the resulting mechanoluminescence within the dotted area (right).

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