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Silicon Crystalline Undulator Based On Silicon Nitride Stressor Layer Patterning: Design and Building from TECHNO-CLS Project

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Current limitations in the field of undulators include the inability of state-of-the-art magnetic undulators to achieve periods shorter than a few centimeters. To overcome these limitations, Crystalline Undulators (CUs) consist of periodically bent crystals [1] in which channeled electrons or positrons follow the bending of the crystalline planes must be developed. These CUs aim to generate intense and monochromatic sources of hard X and ɣ electromagnetic radiation with energies from 100 keV to GeV [2,3].
In this work, we present a novel approach exploiting silicon nitride stressor layer to produce short period CUs. We report the results of finite element method (FEM) analysis of CUs and the evaluation of the optimal geometric parameters for the undulator, revealing detailed 3D deformation and the related emitted radiation spectrum. Additionally, dynamic simulations were conducted using the relativistic atomistic molecular dynamics approach implemented in MBN Explorer [4]. We fabricated first prototypes of CUs using advanced silicon microelectronics techniques, facing significant challenges from an experimental manufacturing perspective.

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