Advanced Photonics Research, vol.6, no.6, pp.2400113-1-2400113-13, June, 2025.

Exploring the Role of Artificial Intelligence in Precision Photonics: A Case Study on Deep Neural Network-Based fs Laser Pulsed Parameter Estimation for MoOx Formation

A. Espinal Jiménez; A.A. Garcia Granada; H. Rostro González; J.R. Paredes Miguel; L. Martinez Jimenez; M. Cano Lara; M.J. Villaseñor Aguilar

Abstract-

Ultrafast pulsed laser technology presents unique challenges and opportunities in material processing and characterization for precision photonics. Herein, an experiment is conducted involving the use of an ultrafast pulsed laser to irradiate a molybdenum film, inducing oxide formation. A total of 54 experiments are performed, varying the laser irradiation time and per-pulse laser fluence, resulting in a database with diverse oxide formations on the material. This dataset is further expanded numerically through interpolation to 187 samples. Subsequently, eight different deep neural network models, each with varying hidden layers and numbers of neurons, are employed to characterize the laser behavior with different parameters. These models are then validated numerically using three different learning rates, and the results are statistically evaluated using three metrics: mean squared error, mean absolute error, and R2 score.

Index Terms- deep neural networks, material characterization, molybdenum thin films, oxide formation, ultrafast pulsed lasers

Citation:
Cano-Lara, M.; Espinal, A.; Garcia-Granada, A.A.; Martinez-Jimenez, L.; Paredes-Miguel, J.R.; Rostro-González, H.; Villaseñor-Aguilar, M.J. "Exploring the Role of Artificial Intelligence in Precision Photonics: A Case Study on Deep Neural Network-Based fs Laser Pulsed Parameter Estimation for MoOx Formation",

Advanced Photonics Research, vol.6, no.6, pp.2400113-1-2400113-13, June, 2025.