# Predictive Multimodal AI model for Laser Processed Material Functions and Properties

Hiroshi Ogawa[1,2,*], Eichi Terasawa[2,3], Daisuke Satoh[1,2], Tatsunori Shibuya[1,2], Sena Maru[3,2], and Ryunosuke Kuroda[2,1]

[1] Research Institute for Measurement and Analytical Instrumentation, National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology, 1-1-1 Umezono, Tsukuba, Japan

[2] AIST-UTokyo Advanced Operando-Measurement Technology Open Innovation Laboratory, National Institute of Advanced Industrial Science and Technology, 5-1-5 Kashiwanoha, Kashiwa, Chiba, Japan

[3] Waseda Research Institute for Science and Engineering, Waseda University, 3-4-1 Okubo, Shinjuku, Tokyo, Japan

*Corresponding author ogawa.h@aist.go.jp

Research has been conducted to impart functions to the surface of materials by laser processing. However, since there are a large number of parameters in the laser process, many experiments are required to obtain the desired function, and especially when trying to predict multiple functions and properties of the processed material, the process parameters to be explored are enormous, and there is a problem that requires a lot of effort.

For example, in the case of an application that imparts wettability to a transparent optical component, there is a reciprocal relationship in which the light transmittance decreases when the wettability is increased, and the cost of searching for process parameters increases as the number of functions and properties increases.

In this study, we developed a multi-modal Artificial Intelligence (AI) that predicts functions and properties (such as wettability and light transmittance) of glass from laser process parameters in surface processing. If you try to build an AI that uses multiple laser process parameters as inputs for AI and wettability and light transmittance as outputs, the correlation between the two is low, so there are problems that the prediction accuracy of the AI cannot be improved and the AI lacks generalization capabilities.

Therefore, in order to solve these problems, instead of creating an AI that predicts functions and properties directly from process parameters, we constructed a generative AI that predicts surface structures manufactured by laser processing that is highly correlated with both laser process parameters and the surface functionality. Using this generative AI, we have developed a multimodal AI consisting of two stages that generates a surface profile from the laser processing parameters and predicts the wettability and transmittance of glass from the AI generated surface shape. We will present the results of verifying whether it is possible to improve prediction accuracy by adopting a multi-modal AI model composed of multiple stages [1] instead of the single AI architecture.

**References**:

[1] S. Muroga, Y. Miki, K. Hata, Adv. Sci. 2023, 10, 2302508.