Toward Continuous-Wave Lasing from Organic Thin Films

T. Matsushima1-3*, A. S. D. Sandanayaka1,2, F. Bencheikh1,2, K. Yoshida1, M. Inoue1, T. Fujihara4, K. Goushi1-3, J.-C. Ribierre1,2, C. Adachi1-3*

1OPERA, Kyushu University, 744 Motooka, Nishi, Fukuoka 819-0395, Japan.
2JST, ERATO, Adachi Molecular Exciton Engineering Project, 744 Motooka, Nishi, Fukuoka 819-0395, Japan.
3WPI-I2CNER, Kyushu University, 744 Motooka, Nishi, Fukuoka 819-0395, Japan.
4ISIT, 5-14 Kyudai-shinmachi, Nishi, Fukuoka 819-0388, Japan.
*Corresponding author. Email: tmatusim@opera.kyushu-u.ac.jp, adachi@cstf.kyushu-u.ac.jp

The demonstration of continuous-wave lasing from organic semiconductor films is highly desirable for practical applications in the areas of spectroscopy, data communication and sensing but it still remains a challenging objective. Here, we report low-threshold surface-emitting organic distributed feedback lasers operating in the quasi-continuous-wave regime at 80 MHz as well as under long pulse photoexcitation of 30 ms (Fig. 1) [1]. This outstanding performance was achieved using an organic semiconductor thin film with high optical gain, high photoluminescence quantum yield and no triplet absorption losses at the lasing wavelength combined with a mixed-order distributed feedback grating to achieve low lasing threshold. A simple encapsulation technique greatly reduced the laser-induced thermal degradation and suppressed the ablation of the gain medium taking place otherwise under intense continuous-wave photo-excitation. Overall, this study provides evidence that the development of a continuous-wave organic semiconductor laser technology is possible via the engineering of the gain medium and the device architecture.

FIG. 1. (a) Photograph of laser emission from our devices. Streak camera images of laser emission from devices operating at (a) 80 MHz and (b) 30 ms.

Reference

2005 PhD (Kyusyu Univ.)
2005-2008 Postdoctoral researcher (Chitose Institute of Science and Technology, Kyushu Univ. and Japan Advanced Institute of Science and Technology)
2008-2014 Assistant Professor (Japan Advanced Institute of Science and Technology)
2014-present Associate Professor (Kyushu Univ.)

Research interest: Organic electronics and perovskite films and devices