【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Interdisciplinary Science and Engineering)

Title of Project : Giant strain effect of charge transport in organic single-crystal semiconductors and flexible mechano-electronics

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Research Project Number : 17H06123 Researcher Number : 20371289
Research Area : Applied materials
Keyword : Organic/Molecular electronics

【Purpose and Background of the Research】

Since organic semiconductors can constitute sensor devices on low cost plastic films, they are attracting attention as promising materials for next generation semiconductors, which are required in large quantities in the upcoming IoT society.
We have found transistors fabricated from single crystalline organic ultra thin films exhibit gigantic strain effects that mobility increases by 70% from 10 cm 2 / Vs by applying a slight force with fingers. The mechanism of huge response is unknown, understanding of micro mechanisms and development of even better material design technology are urgently required. This study aims to elucidate the effect that strain contributes to electron transfer and electron scattering through elaborate physical property studies and elucidate the huge mechano - electronic response mechanism in flexible organic semiconductors.

【Research Methods】

In order to elucidate the whole phenomenon of the huge distortion response phenomenon of the flexible single crystal organic semiconductor crystal, we are working on "development of molecular layer single crystal organic semiconductor / polymer composite material" and "elucidation of structural properties and study of electronic properties of distortion effect" .

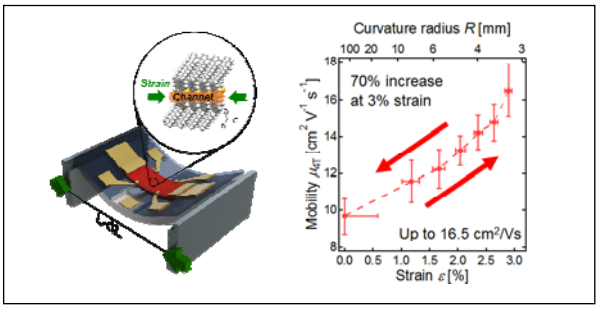

Figure 1 Strained organic semiconductor and strain / mobility characteristics

【Expected Research Achievements and Scientific Significance】

This research aims at "elucidation of a practical structure looking at device construction", and it is expected that ultrahigh - sensitivity strain sensor elements and high - efficiency vibration power generation elements can be realized so far. This ultra-sensitive sensor generates new structure deterioration diagnosis technology and new automatic production technology, and high efficiency power generation element leads to energy harvest by vibration power generation. Devices that combine these elements and printed LSIs create an industrial base of mechano-electronics, greatly advancing the IoT society, encouraging social change by constructing an autonomous network society, and impacting the foundation of innovation in the advanced information society.

【Publications Relevant to the Project】

・Takayoshi Kubo, Roger Häusermann, Junto Tsurumi, Junshi Soeda, Yugo Okada, Yu Yamashita, Norihisa Akamatsu, Atsushi Shishido, Chikahiko Mitsui, Toshihiro Okamoto, Susumu Yanagisawa, Hiroyuki Matsui & Jun Takeya, “Suppressing molecular vibrations in organic semiconductors by inducing strain” Nature Communications 7, 11156 (2016).
・K. Sakai, Y. Okada, S. Kitaoka, J. Tsurumi, Y. Ohishi, A. Fujiwara, K. Takimiya, and J. Takeya, “Anomalous pressure effect in heteroacene organic field-effect transistors”, Phys. Rev. Lett. 110, 096603 (2013).

【Term of Project】 FY2017-2021

【Budget Allocation】 163,300 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.organicel.k.u-tokyo.ac.jp/