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利用形態 : 機器利用
利用課題名(日本語) : 円偏光プラズモン場を用いたキラル結晶化の制御
Program Title (English) : Controlling chiral crystallization with circularly polarized plasmonic fields
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1. 概要(Summary)

In this study, a CW laser with a wavelength of 1064 nm was irradiated on a gold nanogap trimer structure immersed in a saturated aqueous solution of ethylenediamine sulfate (EDS) to form chiral crystals of this organic compound. After repeating this experiment several tens of times for either left or right circularly polarized light, the chiral crystals produced showed high enantioselectivity and achieved a crystal enantiomeric excess exceeding 40%.

2. 実験(Experimental)

【利用した主な装置】

超高精度電子ビーム描画装置 125kV、超高速スキャン高精度電子ビーム露光装置 130kV、ヘリコンスパッタリング装置、電界放射型走査型電子顕微鏡、超高分解能走査型電子顕微鏡

【実験方法】

Gold nanostructures composed of 3 triangles forming a central nanogap (10-20 nm) were designed and fabricated on a thin cover glass. When the nanostructure is irradiated by a circularly polarized light, the electric field in the nanogap is strongly enhanced by the excited plasmonic resonance and the spin angular momentum of the laser light is transferred to this locally enhanced field. Experiments were carried out by dropping a small amount of saturated solution of EDS on the cover glass and irradiating a CW laser with a wavelength of 1064 nm (intensity: 0.8 mW) on a gold nanostructure at the air-liquid interface. Due to the light pressure close to the nanogap, EDS crystals were precipitated from the irradiated point. The experimental conditions were adjusted so that each time a single crystal is always formed. The above procedure was repeated several times using linearly, left circularly, right circularly polarizations. For each polarization condition, the enantiomeric excess was calculated from the total number of d- and l-form chiral crystals.

3. 結果と考察(Results and Discussion)

The polarization dependence of the enantiomeric excess was evaluated. A very high enantiomeric excess of nearly 40% was achieved when the laser intensity was low (0.8 mW) but the value decreased when the laser intensity was increased to 1.6mW, suggesting that the CEE decreased due to the temperature rise at the hotspot. Further work will be done to achieve a higher enantiomeric excess and elucidating the mechanism of enantioselectivity.

4. その他・特記事項(Others)

・本研究は、新学術領域研究「光圧によるナノ物質操作と秩序の創生」(JP16H06506)の一環として、台湾交通大学との共同で行った。
・共同研究者 北海道大学電子科学研究所 笹木敬司

5. 論文・学会発表(Publication/Presentation)

(1) Cheng, A. C., Niinomi, H., Omatsu, T., Ishida, S., Sasaki, K., and Sugiyama, T., "Plasmonic Manipulation-Controlled Chiral Crystallization of Sodium Chlorate," J. Phys. Chem. Lett. 11, 4422-4426 (2020).

6. 関連特許(Patent)

なし。