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Project No. 2064

Self-propelled aero-GaN liquid marbles rotating in pulses

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［2］ Research Progress

We have developed gallium nitride hollow microtetrapods with the thickness of the walls of about a few tens of nanometers. The inner surface of the microtetrapods is covered by an ultrathin film of ZnO which leads to the occurrence of fascinating dual hydrophilic/hydrophobic properties, the hydrophilicity being caused by the inner ZnO coverage, while hydrophobicity being inherent to outer GaN surface. Microtetrapods prepared in different technological conditions have been used to fabricate self-propelled liquid marbles which represent droplets consisting of aqueous solutions of alcohol covered by a layer of microtetrapods. The phenomenon of self-propulsion proves to be caused by the Marangoni solutocapillary flow emerging when a gradient of surface tension of the fluid support is generated in the surrounding vicinity of the liquid marble [I. Tiginyanu, T. Braniste *et al*, Nano Energy, Vol. 56, 759-769 (2019)]. We found that the liquid marbles exhibit rectilinear or rotational motion as well as combined translational and rotational motion, and studied the features of the motion as a function of various parameters, including weight of marbles, technological conditions for the preparation of GaN microtetrapods, shape of liquid marbles etc. As a result, the shape of the marbles was identified to be the key parameter determining the type of motion of liquid marbles under consideration.

［3］ Results

(３－１) Research results

We studied two types of liquid marbles, namely marbles with spherical shape and marbles with elongated ellipsoidal shape. We established that marbles with spherical shape exhibit rectilinear motion, while marbles with elongated ellipsoidal shape show rotational or combined translational and rotational motion. The marbles characterized by rotational motion are divided into two types: exhibiting uniform rotation and pulsed rotation.

(３－２) Ripple effects and further developments

In case of uniform rotation, we found that the bigger the weight, the smaller the speed of rotation of marbles. Pulsed rotation was detected for relatively light liquid marbles. The most intriguing phenomenon is the existence of a threshold speed for liquid marbles rotating in pulses. In other words, a liquid marble characterized by self-propelled spinning starts to rotate with acceleration, and after reaching a threshold speed exhibits sharp braking. The acceleration and braking processes are repeated on their own, the attained threshold speed being practically the same within half an hour. For example, a self-propelled liquid marble with the weight of 6.5 mg shows periodic acceleration and braking, and the maximum rotational speed attained is as high as 4 rotations per second. At present an analytical model is under development for the purpose of throwing light upon the observed phenomena. The experimental and analytical data will be used to write and promote a joint research paper.

［4］ Achievements (List of Publications)

We have no joint publications on this subject yet.

No travel has been realized up to now under this joint project.