Science and Applications of One-Dimensional Peanut-Shaped C_{60} Polymer

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ABSTRACT

We have found that electron-beam (3–7 keV) induced C_{60} polymerization results in formation of one-dimensional (1D) metallic peanut-shaped (concave-convex) C_{60} polymers *via* the generalized Stone-Wales transformation under ultrahigh vacuum conditions [1]. This enables us to control the physicochemical properties of C_{60} films using electron-beam lithography technique. It is interesting to note that the 1D polymer exhibits the geometrical curvature effects on Tomonaga-Luttinger liquid (TLL) state [2]. The behavior of the electron on the curved surface is based on the Hamilton operator expressing the following equation.

$$\hat{H} = -\frac{\hbar^2}{2m^*}\left[\frac{1}{\sqrt{g}}\sum_{i,j=1}^{2}\frac{\partial}{\partial q^i}\left(\sqrt{g}\,g^{ij}\frac{\partial}{\partial q^j}\right) + (h^2 - k)\right]$$

Here, $g = \det[g_{ij}]$ represents the metric tensor. The first term is an operator of the kinetic energy of electrons, and the second term consisting of the mean curvature h and the Gaussian curvature k appears like a scalar potential. So far, it has been a mystery whether or not this curvature term affects the behavior of electrons since 1950s.

We have theoretically predicted the effects of the geometric curvature term on the electronic behavior of the above 1D C_{60} polymer [3] and then experimentally demonstrated it [2]. This finding will cultivate an interdisciplinary between modern geometry and materials science (quantum mechanics in submanifold) [4]. As shown in Fig. 1, I will introduce the fundamental properties and potential applications of the 1D C_{60} polymer along with related nanocarbon materials [5].

References

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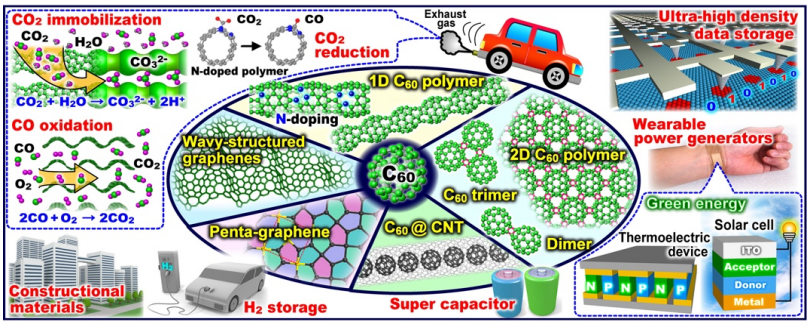

Figure 1. Schematic illustration of C_{60}-based low-dimensional nanocarbons: structures and potential applications based on their fundamental properties [5].