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Quantum molecular spintronics based on multiple-decker phthalocyaninato lanthanide (III) single-molecule magnets

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Spintronics is a key technology in 21st century based on the freedoms of the charge, spin, as well as orbital of the electron. The MRAM systems (magnetic random access memory) by using GMR, CMR or TMR have several advantages such as no volatility of information, the high operation speed of nanoseconds, the high information memory storage density, and the low consuming electric power. Usually in these systems, the bulk magnets composed of the transition metal ions or conventional magnets are used, while in our study we will use single-molecule quantum magnets (SMMs), which are composed of multi-nuclear metal complexes and nano-size magnets. Moreover, SMMs show the slow magnetic relaxations with the double-well potential defined as $|D|S^2$ and the quantum tunneling. Although the bulk magnets are used in conventional spintronics with the largest spin quantum number of 5/2 for example, we can create the artificial spin quantum numbers of 10, 20, 30, etc. in SMMs. Then, we can realize the new quantum molecular spintronics by using SMMs. According to such a strategy, we have synthesized the conducting SMM such as $[Pc_2Tb]Cl_{0.6}$, whose blocking temperature is 47 K. The hysteresis is observed below 10 K. This SMM shows the negative magnetoresistance below 8 K. As for the second strategy, we have a plane of the input/output of one memory into/from double-decker Tb(III) SMM (Pc_2Tb) by using the spin polarized STM (scanning tunneling microscopy). In this research, we have observed Kondo Effect at 4.8 K by using STS (scanning tunneling spectroscopy) for the first time. We have succeeded in controlling the appearance and disappearance of Kondo Peak by the electron injection using STS, reversibly. This is considered as the first single-molecule memory device. As for the third strategy, we have made the FET (field effect transistor) devices of SMMs. The Pc_2Dy device shows the ambipolar (n- and p-type) behavior, while the Pc_2Tb device shows the p-type behavior. Such a difference is explained by the energy levels of the lanthanide ions. As for the fourth strategy, we have made doping of Cs atoms onto Pc_2Y, where Kondo peaks have not observed by coupling of radical of Pc and s electron of Cs atom to make a single pair, while other Pc_2Y shows Kondo peak due to their radicals. Finally, we have succeeded to write the letters of T and U, which are the initials of Tohoku University.

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Boronizing: An effective surface treatment for plain carbon steels over high alloy steels

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Over the years the world has been in the look out of novel materials and technologies that would lead to a better tomorrow. Scientists, Technologists, Academicians have been working together to meet this objective. Surface Coating or Surface Deposition is not an uncommon technique while one desires to enhance the characteristics of the surface. Moreover, the thickness, orientation, growth kinetics, and adherence of the coating can be regulated through monitoring the parameters like Temperature, time, ambiance, and the nature of the substrate. The present paper critically discusses one of the surface coating technologies known as boronizing. The two steel substrates were so chosen that they differ wide in their characteristics. After boronizing, the case depth, microhardness distribution, and microstructural analysis were done on the coated substrates. The results were compared against each other. Conclusions were drawn on the basis of results obtained.

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