Three-dimensional polymer with unusual magnetism

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Up to now it has not been possible to fabricate magnets from organic materials, like for example plastics. Recently, however, experiments at the Forschungszentrum Dresden-Rossendorf (Germany) in collaboration with an international research team have revealed magnetic order in a polymer. The structure which consists in particular of hydrogen, fluorine, carbon and copper, has been realized in an entirely novel, three-dimensional and very stable form. This will be described in an upcoming issue of the journal *Chemical Communications*.

Magnetism is a physical property of matter related to the magnetic spins of electrons. Iron, for example, is a ferromagnet because these spins are aligned parallel to each other, generating a uniform magnetic field. Antiferromagnetism, on the other hand, arises when neighboring spins are oriented antiparallel to each other.

Such antiferromagnetism has been shown to exist for the new polymeric compound studied at the Forschungszentrum Dresden-Rossendorf (FZD). This polymer is characterized by a novel and unusual structure where copper atoms together with pyrazin-molecules build layers, which in turn through bridges of hydrogen and fluorine are connected with each other. The three-dimensional polymer was prepared by chemists working with Jamie Manson at Eastern Washington University and was subsequently studied by physics teams in Great Britain and in the research center in Dresden-Rossendorf.

Metallic copper is not magnetic. Joachim Wosnitza and his colleagues at

the Dresden High Magnetic Field Laboratory discovered at a temperature of 1.54 Kelvin – that is 1.54 degrees above absolute zero at -273.15 °C – that the embedded copper atoms order themselves antiferromagnetically. In the compound, every copper ion possesses a magnetic spin which interacts with neighboring spins through organic units. How this interaction arises and how it can be influenced is presently under investigation.

Additional polymeric samples from the laboratory of Manson will be studied at the Forschungszentrum Dresden-Rossendorf with the objective of a better understanding of the newly discovered magnetism for this class of polymers. In the future, this would be a significant step, to synthesize organic materials with tailored magnetic properties. Permanent magnets can be made from iron and other ferromagnetic materials, from polymers this is, according to the current knowledge, not possible. The great vision of the scientists is to realize ferromagnetic properties for novel polymeric compounds that eventually would permit the development of innovative magnets.

Source: Forschungszentrum Rossendorf