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## Improvement of magnetic properties using high magnetic fields

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This research project had two prongs: developing materials (usually non-magnetic) to be used in the construction of high-field electromagnets, and using these high-field magnets in the development of new permanent magnetic materials. We developed nanostructured composite conductors with very high mechanical strength for our magnet coils, and we also developed very strong structural materials to reinforce those coils. The work done in this study was a key factor in the recent establishment by the US of new world records in high magnetic field production. Because of the high cost of Nd metals, our study on permanent magnetic materials was focused on improving current alternatives to Nd-based magnetic materials. The bulk Mn80-xGa20x system, for example, has hard magnetic properties but a low magnetic moment. We developed two ways to enhance the magnetic moment. The first is magnetic field annealing (MFA), which improved the magnetic moment by more than 50%. The second is to partially replace Mn with other alloy elements, such as FeB compound, resulting in a hard magnetic material with an increased magnetic moment. The addition of FeB was found to have doubled the magnetic moment of the binary system. The other example is Iron-Cerium-Boron (Fe-Ce-B). We enhanced the magnetic properties of Fe-Ce-B ribbons by engineering both microstructure and volume fraction of the Ce2Fe14B phase through optimization of the chamber pressure and the wheel speed necessary for rapid solidification achieved.

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