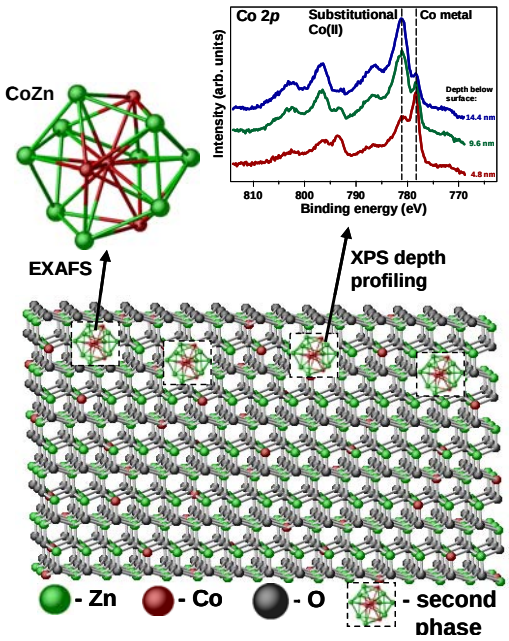
New study shows hidden secondary phases in cobalt-doped zinc oxide

Minute quantities of CoZn led to spurious ferromagnetism

Significant research has focused on investigating materials for spintronic computer circuits, which could use electronic spin, rather than charge, to process data. No consensus has been reached on whether one intensely studied material—cobalt-doped zinc oxide—shows the intrinsic ferromagnetism necessary for spintronics. Recently, scientists from Pacific Northwest National Laboratory and the Advanced Photon Source at Argonne National Laboratory showed that, while Co:ZnO treated in zinc vapor demonstrated ferromagnetism, the signal did not originate in the doped material but instead from minute quantities of cobalt or cobalt and zinc that formed in secondary phases.

At the Department of Energy's EMSL, the team carefully characterized thin films of Co:ZnO after the material was treated with zinc vapor. Using EMSL's x-ray photoelectron spectroscopy, the team demonstrated that Co:ZnO ferromagnetism is due to small clusters of ferromagnetic cobalt that formed near the oxide's surface during zinc treatment, not an inherent magnetism in the material.

Further investigation by x-ray absorption fine structure spectroscopy at DOE's Advanced Photon Source identified the ferromagnetic secondary phase as intermetallic cobalt-zinc, with an unusual structure and ferromagnetic properties, which formed in the doping process.



Zinc vapor treatment of Co:ZnO thin films induced ferromagnetism; however, a combination of materials characterization techniques identified the source as small quantities of secondary phase CoZn that formed during treatment. The observed ferromagnetism was correlated to this secondary phase.

Scientific impact: This research highlights the value of integrated instrument suites in studying claims of intrinsic ferromagnetism in materials such as Co:ZnO. Painstaking characterization is vital before claims of intrinsic ferromagnetism can be made in spintronic materials. This work is just one example of the research conducted at EMSL to characterize surfaces and interfaces with unprecedented spatial resolution.

Social impact: Spintronics could revolutionize the computer industry, allowing for very small and powerful computer chips. By eliminating materials whose ferromagnetism originates in secondary phases, researchers and funding agencies can better focus resources on promising materials.

For more information, contact EMSL Communications Manager Mary Ann Showalter (509-371-6017).

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