Supplemental Material for *"Fundamental Crystal Field Excitations in Magnetic Semiconductor SnO_2:Mn,Fe,Co,Ni"*

B. Leedahl,[1] D. J. McCloskey,[1] D. W. Boukhvalov,[2,3] I. S. Zhidkov,[3] A. I. Kukharenko,[3] E. Z. Kurmaev,[3,4] S. O. Cholakh,[3] N. V. Gavrilov,[5] V. I. Brinzari,[6] and A. Moewes[1]

[1] *Department of Physics and Engineering Physics, University of Saskatchewan, 116 Science Place, Saskatoon, Saskatchewan S7N 5E2, Canada**

[2] *College of Science, Institute of Materials Physics and Chemistry, Nanjing Forestry University, Nanjing 210037, P. R. China*

[3] *Institute of Physics and Technology, Ural Federal University, Mira 9 str., 620002 Yekaterinburg, Russia*

[4] *M.N. Mikheev Institute of Metal Physics of Ural Branch of Russian Academy of Sciences, S. Kovalevskoi 18 str., 620990 Yekaterinburg, Russia*

[5] *Institute of Electrophysics, Russian Academy of Sciences, Ural Branch, 620990 Yekaterinburg, Russia*

[6] *Pokatilov Laboratory of Physics and Engineering of Nanomaterials, Department of Theoretical Physics, Moldova State University, Chisinau MD-2009, Republic of Moldova*

	Ox. State.	$10Dq$	Ds	Dt	β
Mn	2+	0.65	0	0	0.2
Fe	2+	1.0	0	0	0.5
Fe	3+	1.5	0	0	0.7
Co	2+	1.8	-0.03	0.03	0.67
Ni	2+	1.55	0	0	0.5

TABLE S1. Shown are the crystal field parameters for the calculated XAS and RIXS spectra in Figures 2 and 3 of main manuscript. The units for $10Dq$, Ds, and Dt are eV, while β is unitless and corresponds to the scaling of the interatomic Slater integrals.

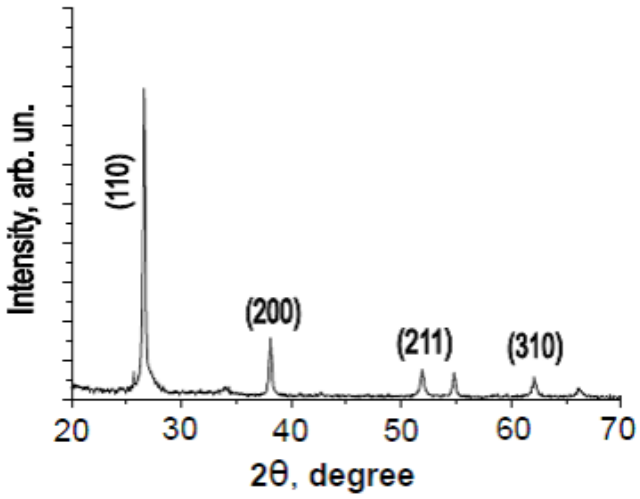

FIG. S1. XRD pattern of SnO_2 undoped films (before implantation) deposited by spray pyrolysis. $T_{deposition} = 450°C$. Film thickness $\approx 100\,nm$.

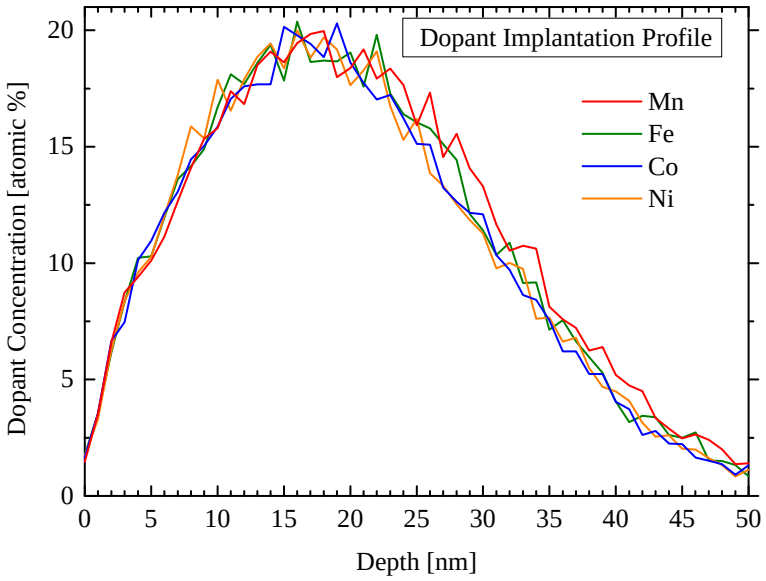

FIG. S2. Calculated dopant profile due to ion implantation. The absolute concentration was estimated using the XPS survey spectra which is sensitive to the first $\approx 5\,\mathrm{nm}$. While the shape profile was estimated using SRIM software. As expected, there is no significant difference between dopants.