

【M-01】 초칭강연

Direct Observation of Barkhausen Avalanche in Co Thin Films

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It is recognized that the magnetization reverses with a sequence of discrete and jerky jumps, known as the Barkhausen effect. Recently, interest in the Barkhausen effect has grown as it is a good example of dynamical critical behavior, evidenced by experimental observation of a power law distribution of the Barkhausen jump size. So far, most experimental studies have been carried out on bulk samples using a classical inductive technique, which is difficult to apply to thin films mainly due to the low signal intensity. In this talk, we report a direct domain observation of Barkhausen avalanche at criticality in Co thin films investigated by means of a magneto-optical microscope magnetometer (MOMM), capable of time-resolved domain observation in real time. Through a statistical analysis of the fluctuating size of Barkhausen jump from more than 1000-times repetitive experiments for each sample, distribution of Barkhausen jump size is found to exhibit a power law behavior and fitted as $P(s) \sim s^{-\tau}$ with critical exponent $\tau = 1.34 \pm 0.07$, 1.29 ± 0.06 , 1.32 ± 0.03 , and 1.30 ± 0.05 for 5, 10, 25, and 50-nm Co films, respectively, as plotted in Fig. 1. Most striking feature is the fact that the τ values are in the same universality class ($\sim 4/3$) for all samples within the measurement error despite of the difference in the film thickness, which implies an invariance of the critical exponent τ irrespective of the

Figure 1 is a log-log plot showing the distribution of Barkhausen jump size $P(s)$ (in arbitrary units, A.U.) versus Jump Size s (μm^2). The main plot shows data for four different film thicknesses: 5 nm (squares, x1000), 10 nm (circles, x500), 25 nm (triangles, x200), and 50 nm (inverted triangles, x50). A dashed line indicates a power-law fit with a critical exponent $\tau = 4/3$. The film thickness $t_{\text{Co}} = 25 \text{ nm}$ is noted in the top right. Three inset plots show zoomed-in views of the data for 5 nm, 10 nm, and 50 nm films, each with its own power-law fit and critical exponent τ value: $\tau \sim 5 \text{ nm}$, $\tau \sim 10 \text{ nm}$, and $\tau \sim 50 \text{ nm}$.

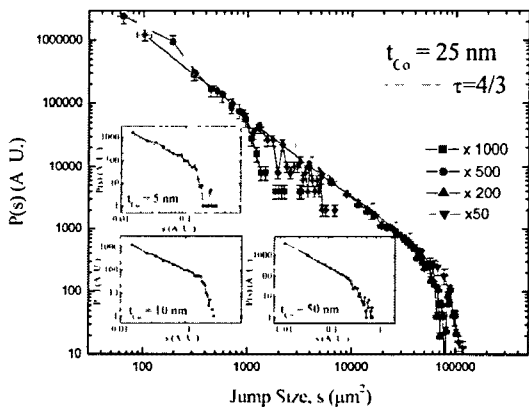


FIG. 1. Distribution of Barkhausen jump size.

Figure 1. Most striking feature is the fact that the τ values are in the same universality class ($\sim 4/3$) for all samples within the measurement error despite of the difference in the film thickness, which implies an invariance of the critical exponent τ irrespective of the

number of defects in Co thin films.⁽¹⁾

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1. D.-H. Kim, S.-B. Choe, and S.-C. Shin, Phys. Rev. Lett. 90, 87203 (2003).