Spin Orbit Torque in Amorphous materials

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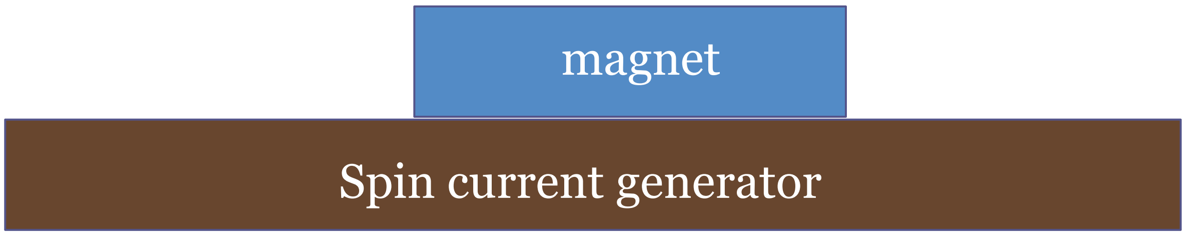
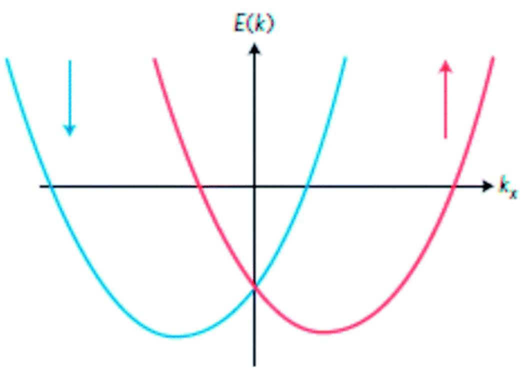
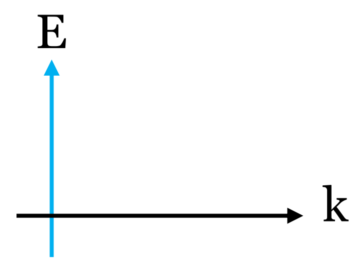
Spin Orbit Torque





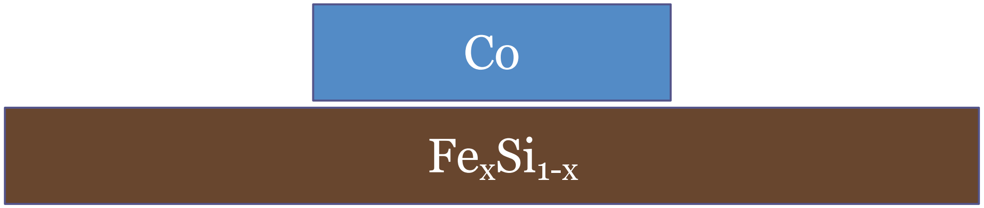
[Giant Spin Hall Effect]

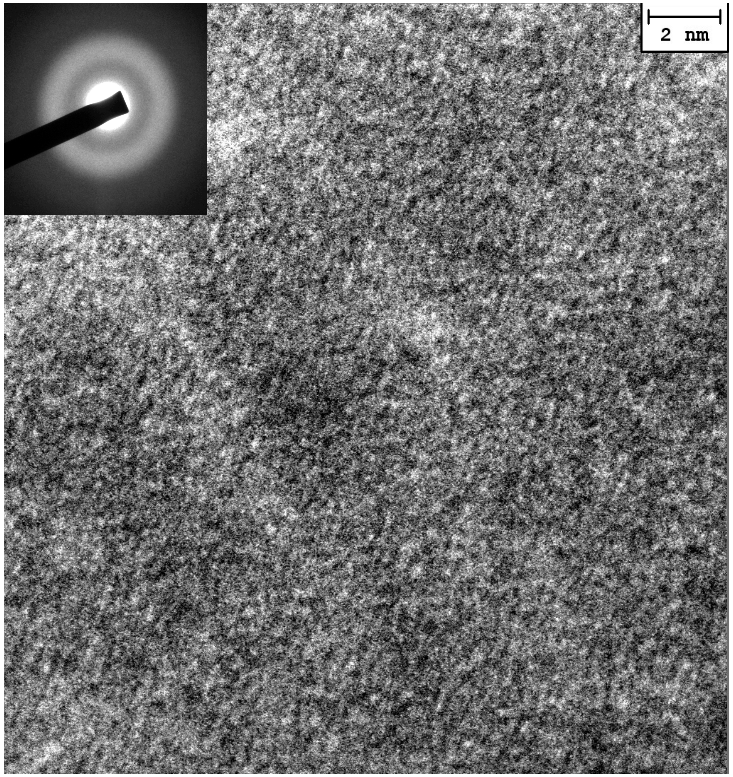


$$\bar{B} = \alpha \bar{E} \times \bar{k}$$

[interface effect]

Amorphous Fe_xSi_{1-x}





Harmonic Analysis

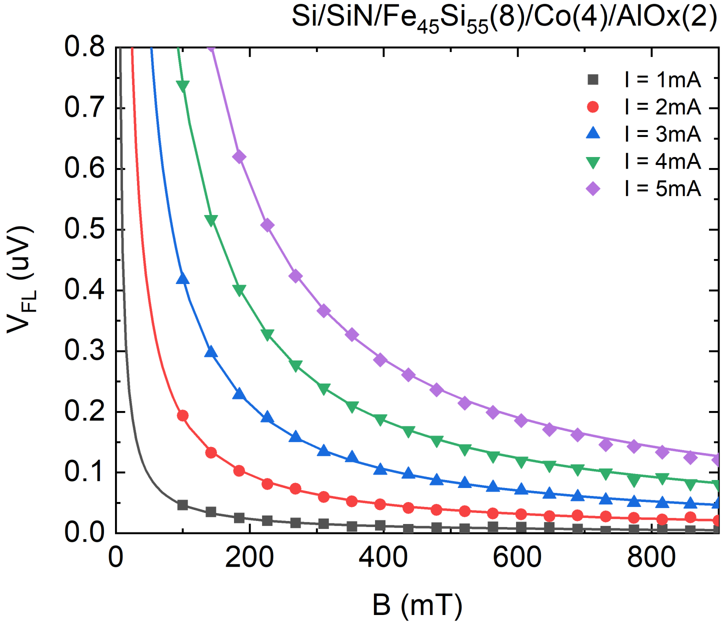
$$V_{xy}^{2\omega} = \left(\frac{V_{\mathrm{AHE}}}{2}\frac{\Delta B_{\mathrm{DL},y}^{\mathrm{IP}}}{B_{\mathrm{ex}} + \mu_0 M_{\mathrm{eff}}} + \alpha\nabla T + \beta\nabla T \cdot B_{\mathrm{ext}}\right)\cos(\varphi_{\mathrm{B}}) + \left(V_{\mathrm{PHE}}\frac{\Delta B_{\mathrm{FL},y}^{\mathrm{IP}}}{B_{\mathrm{ext}}}\right)\cos(2\varphi_{\mathrm{B}})\cos(\varphi_{\mathrm{B}})$$

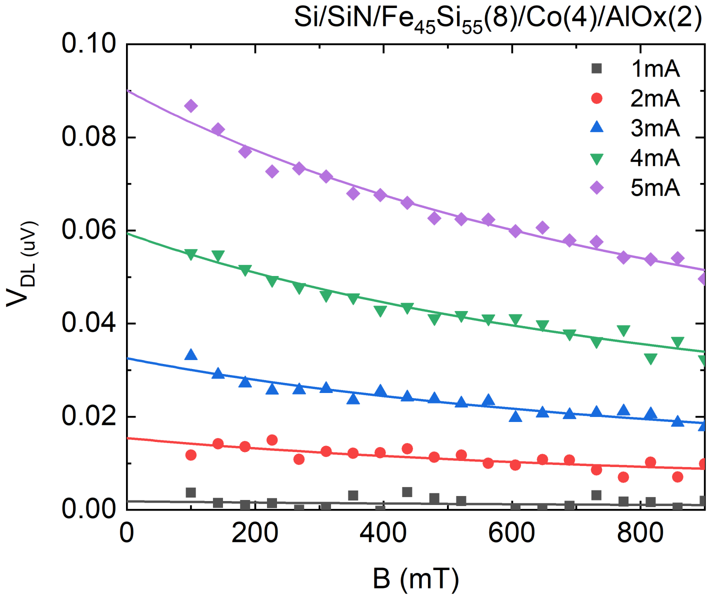
Damping-like Torque

anomalous Nernst Effect

ordinary Nernst Effect

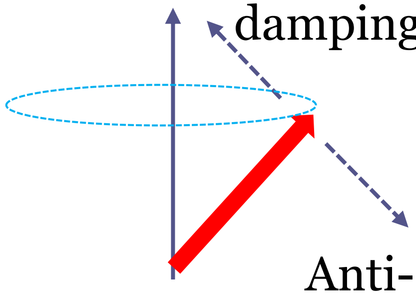
Field-like Torque

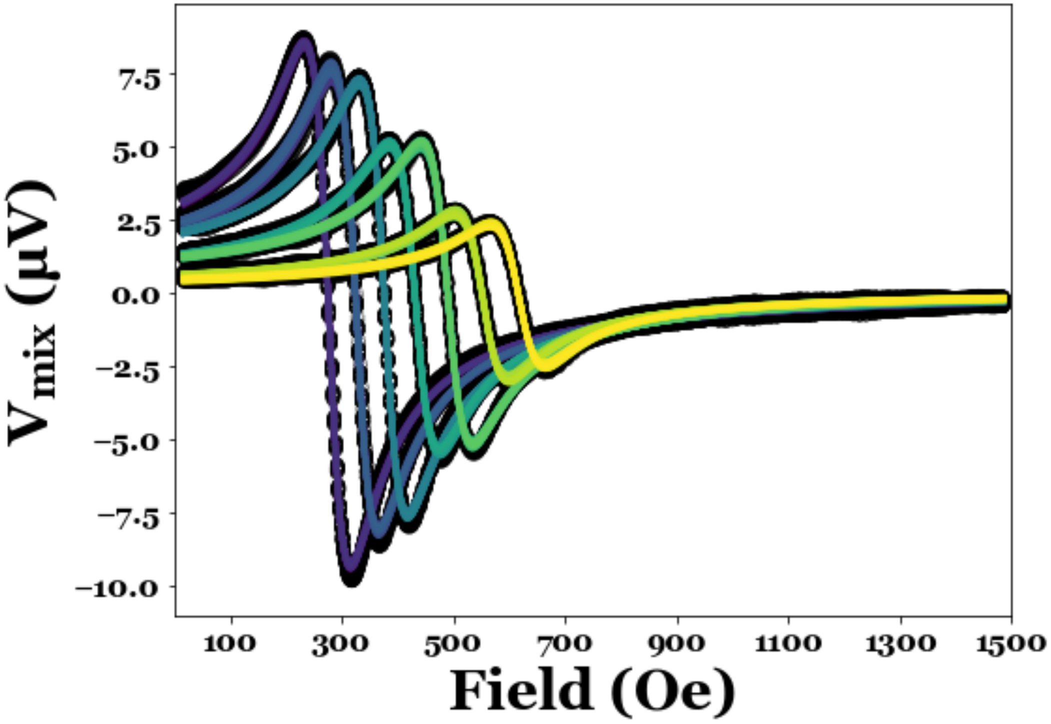




$$\theta_{\mathrm{SHA}} = \frac{2e}{\hbar} M_S t_{\mathrm{FM}} \frac{B_{\mathrm{dl}}}{j_{\mathrm{FeSi}}} \qquad \cong 3.03\%$$

ST-FMR





$$\theta_{SHA} = \frac{V_S}{V_A}\frac{e\mu_0 M_s t d}{\hbar}\sqrt{1+\frac{4\pi M_{eff}}{H_{ext}}} \sim 2.74\%$$

Conclusion

- Sizable spin orbit torque (~3%) was observed in completely amorphous material
- Two independent methods provide consistent results
- Indicates purely interface driven SOT is possible