

Supporting Information

**Magnetic properties of epitaxial TmFe_2O_4 thin film with
anomalous interface structure**

You Jin Kim,[†] Shinya Konishi,[†] Yuichiro Hayasaka,[‡] Ryo Ota,[§]

Ryosuke Tomozawa,[†] Katsuhisa Tanaka^{*,†}

[†]Department of Material Chemistry, Graduate School of Engineering, Kyoto University,

Katsura, Nishikyo-ku, Kyoto 615-8510, Japan

[‡]The Electron Microscopy Center, Tohoku University, Sendai, Miyagi Prefecture 980-8577,

Japan

[§]HVEM Laboratory at Center for Advanced Research of Energy and Materials, Graduate

School of Engineering, Hokkaido University, Kita 13-jo, Nishi 8-chome, Sapporo 060-8628,

Japan

Contents

1. **Table S1:** Results of inductively coupled plasma atomic emission spectroscopy (ICP-AES) for TmFe_2O_4 polycrystals prepared under various CO/CO_2 ratios.
2. **Figure S1:** Atomic force microscopic (AFM) images of YSZ substrate and TmFe_2O_4 thin film.
3. **Figure S2:** High-angle annular dark-field scanning transmission electron microscopic (HAADF-STEM) image, results of energy dispersive X-ray spectroscopy (EDX), and selected area electron diffraction (SAED) pattern for impurity phases.
4. **Figure S3:** A rocking curve for YSZ (111) substrate used in the present study. The full-width at half maximum obtained from the rocking curve is 0.0305° .

Table S1. The molar fractions of Tm and Fe analyzed by ICP-AES for TmFe_2O_4 polycrystals

prepared under various CO/CO₂ ratios. The compositions of the samples are almost stoichiometric although subtle deviations from the stoichiometry are observed. The values of concentration for Fe and Tm are averaged ones obtained by repeating the measurements three times. The experimental error is within 1 %.

CO/CO ₂ molar ratio	Molality of Fe (mol/kg)	Molality of Tm (mol/kg)	Fe/Tm ratio
1	5.56	2.86	1.94
2/3	5.58	2.85	1.96
1/2	5.48	2.80	1.96
1/3	5.38	2.67	2.01
1/4	5.43	2.64	2.05

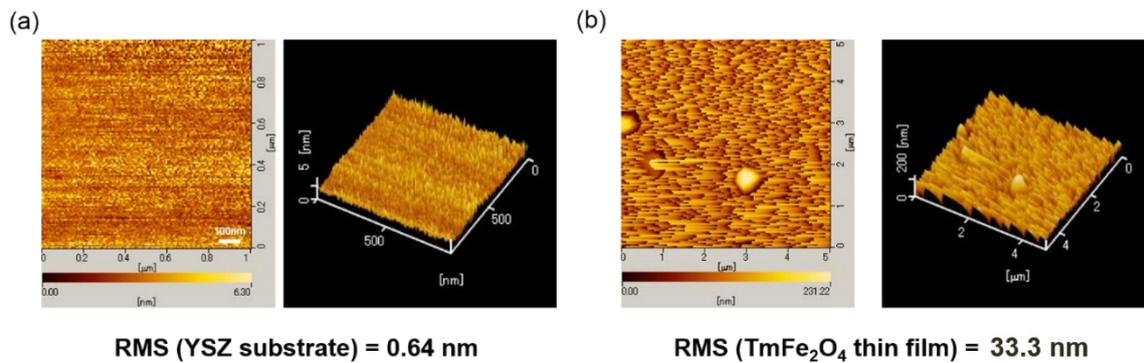


Figure S1. AFM images of YSZ substrate and TmFe₂O₄ thin film.

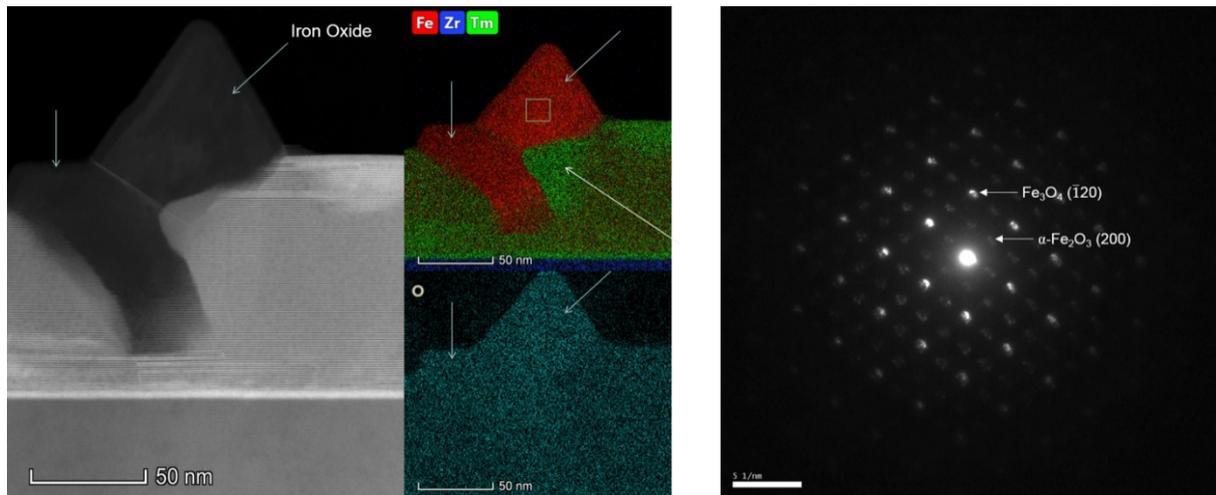


Figure S2. HAADF-STEM image, distribution of elements determined by EDX, and SAED pattern of impurity phases observed in a limited region of TmFe_2O_4 thin film. The SAED pattern indicates that the impurity phases are Fe_3O_4 and $\alpha\text{-Fe}_2\text{O}_3$.

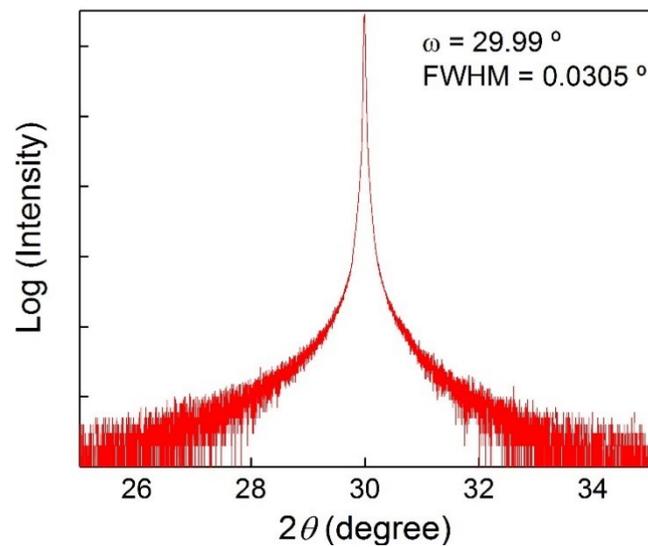


Figure S3. A rocking curve for YSZ (111) substrate. The full-width at half maximum obtained from the rocking curve is 0.0305° .