



(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0044703 A1**

Inomata et al.

(43) **Pub. Date: Mar. 2, 2006**

(54) **SPIN INJECTION DEVICE, MAGNETIC DEVICE USING THE SAME, MAGNETIC THIN FILM USED IN THE SAME**

Dec. 9, 2003 (JP) 2003-410966

Publication Classification

(75) Inventors: **Kouichiro Inomata**, Sendai-shi (JP);
Nobuki Tezuka, Sendai-shi (JP)

(51) **Int. Cl.**
G11B 5/127 (2006.01)

(52) **U.S. Cl.** **360/324.1**

Correspondence Address:

WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP
1250 CONNECTICUT AVENUE, NW
SUITE 700
WASHINGTON, DC 20036 (US)

(57) **ABSTRACT**

A spin injection device capable of spin injection magnetization reversal at low current density, a magnetic apparatus using the same, and magnetic thin film using the same, whereby the spin injection device (14) including a spin injection part (1) comprising a spin polarization part (9) including a ferromagnetic fixed layer (26) and an injection junction part (7) of nonmagnetic layer, and a ferromagnetic free layer (27) provided in contact with the spin injection part (1) is such that in which the nonmagnetic layer (7) is made of either an insulator (12) or a conductor (25), a nonmagnetic layer (28) is provided on the surface of the ferromagnetic free layer (27), electric current is flown in the direction perpendicular to the film surface of the spin injection device (14), and the magnetization of the ferromagnetic free layer (27) is reversed. This is applicable to such various magnetic apparatuses and magnetic memory devices as super gigabit large capacity, high speed, non-volatile MRAM and the like.

(73) Assignee: **JAPAN SCIENCE AND TECHNOLOGY AGENCY**, Kawaguchi-shi (JP)

(21) Appl. No.: **10/538,689**

(22) PCT Filed: **Dec. 11, 2003**

(86) PCT No.: **PCT/JP03/15888**

(30) **Foreign Application Priority Data**

Dec. 13, 2002 (JP) 2002-363127
Dec. 26, 2002 (JP) 2002-378502
Jul. 7, 2003 (JP) 2003-271628

