



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <b>(21) International Application Number:</b> PCT/US99/22356<br><br><b>(22) International Filing Date:</b> 28 September 1999 (28.09.99)<br><br><b>(30) Priority Data:</b><br>60/102,188                      28 September 1998 (28.09.98)    US<br><br><b>(71) Applicant (for all designated States except US):</b> SEAGATE TECHNOLOGY, INC. [US/US]; Intellectual Property, Building 15, 920 Disc Drive, Scotts Valley, CA 95066 (US).<br><br><b>(72) Inventor; and</b><br><b>(75) Inventor/Applicant (for US only):</b> EVERITT, Brenda, A. [US/US]; 5213 Washburn Avenue S., Minneapolis, MN 55410 (US).<br><br><b>(74) Agent:</b> BRUESS, Steven, C.; Merchant & Gould P.C., 3100 Norwest Center, 90 South Seventh Street, Minneapolis, MN 55402-4131 (US). |           | <b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).<br><br><b>Published</b><br><i>With international search report.</i><br><i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> |

**(54) Title:** QUAD-LAYER GMR SANDWICH**(57) Abstract**

A magnetoresistive (GMR) sensor includes a substrate and a first trilayer disposed on the substrate. A first spacer layer is disposed on the first trilayer. A first magnetic layer is disposed on the first spacer. A second spacer layer is disposed on the first magnetic layer. A second magnetic layer is disposed on the second spacer layer. A third spacer layer is disposed on the second magnetic layer. A second trilayer is disposed on the third spacer layer and a cap layer is disposed on the second trilayer. The first and second trilayers include, a first ferromagnetic layer, a second ferromagnetic layer and an anti-parallel coupling layer disposed between and in contact with the first and second ferromagnetic layers.

