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Spintronic Devices for Efficient Computing

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Since the development of magnetic random access memory using spin-transfer torque reached its commercialisation phase, spintronics has entered a new era. For further improvement and implementation of spintronic devices, a new ferromagnetic material with a small damping constant below 0.001 and 100% spin polarisation is required to be developed in a film form at room temperature [1, 2]. Especially, Heusler alloys have been attracting intensive attention to satisfy these requirements by crystallising it into a perfectly ordered phase but at high temperature, typically above 400°C [3]. We have recently developed a new process to reduce the crystallisation temperature down to 80°C for a Heusler alloy film grown on a (110)-oriented seed layer [4], which is compatible with the current memory fabrication process.

Giant magnetoresistive junctions consisting of a Heusler alloy, Co2FeAl0.5Si0.5/Ag/Co2FeAl0.5Si0.5, were grown by ultrahigh vacuum sputtering. They show only a small resistance change but their structures can be optimised further. For highly efficient operation, the corresponding switching current density was demonstrated to be controlled by replacing oxide insulating layers to isolate top and bottom electrodes by a ferromagnetic oxide layer to induce spin wave to assist the current-induced magnetisation switching.

These junctions were also characterised by non-destructive imaging to observe the quality of the buried junction interfaces with scanning electron microscopy we developed recently [5]. We managed to improve the yield of such junctions by 15% by identifying the cause of damages with our imaging technique. Additionally, this technique was applied to magnetic tunnel junctions for the improvement of their properties. These results pave a way for further improvement of the spintronic devices.

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