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Present status and issues of oxide-based flexible electronics

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Amorphous oxide semiconductor (AOS) [1,2] is employed for thin-film transistors (TFTs) in high-resolution liquid-crystal displays and large-size organic light-emitting diode displays owing to large field-effect mobilities > 10 $cm^2/(Vs)$ and good uniformity of AOS TFTs. They are also expected for flexible electronic devices because AOS TFTs exhibit the good performances even when fabricated at room temperature. On the other hand, it is also known that AOS TFTs require post-fabrication thermal annealing typically at 300-400^{o}C in air or O_2 in order to improve uniformity and stability. Therefore, good AOS-based flexible displays have been reported using high-softening temperature substrates such as stainless steel and polyimide. There are alternative approaches that utilize transfer techniques; i.e., TFT and OLED layers are first formed on glass, and then these layers are detached and transferred to a flexible plastic substrate. Of course, it would be much favorable to develop a low-temperature process so that flexible devices may be directly formed on inexpensive low-softening temperature substrates.

In this paper, we will first give a review on the present status of commercialization of AOS-related devices along with those of applications to flexible devices and solution/non-vacuum processes. Then, we will discuss the issues to realize practical performances of flexible devices based on AOS. To lower the process temperature, it is important to understand defect structures, their origins, and their thermal relaxation dynamics to reduce the defect density at a low temperature. Therefore, next we will discuss defect species that have been elucidated in AOSs (oxygen deficiency, weakly-bonded oxygen, peroxy linkage, hydrogen etc), and their annihilation processes by thermal annealing along with defect passivation processes.

[1] Nomura et al., Nature **432** (2004) 488
[2] Kamiya et al., Sci. Tech. Adv. Mater. **11** (2010) 044305;