15th International Symposium on Fusion Nuclear Technology (ISFNT-15)
10.-15.09.2023, Las Palmas de Gran Canaria, Spain.

SMART materials for DEMO: towards industrial production

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Self-passivating Metal Alloys with Reduced Thermo-oxidation (SMART) are under development for plasma-facing components of the future fusion power plant, such as DEMO. SMART materials containing chromium, yttrium and tungsten exhibit similar sputtering resistance as that of pure tungsten during regular plasma operation. In case of an accident combining loss-of-coolant and air ingress into the vacuum vessel, SMART demonstrate the suppression of oxidation outperforming tungsten.

The viability of SMART concept has been shown at the laboratory scale. SMART materials and pure tungsten have demonstrated identical sputtering resistance during deuterium plasma exposures under conditions corresponding to 20 days of continuous plasma operation of the power plant. Under accident conditions, SMART features remarkable 10^4-fold suppression of oxidation and more than 40-fold mitigation of sublimation of tungsten oxide as compared to those of pure tungsten.

Presently, the scale-up of SMART technology is underway involving industrial partners. This activity comprises the industrially supplied feedstock materials for SMART, mechanical alloying of SMART powder at industry and field-assisted sintering of SMART materials using industrial equipment.

Industrial mechanical alloying already now can be accomplished within 20 hours of milling, instead of 60 required earlier at laboratory scale, providing at least four kilograms of fully alloyed powder per session.

At the same time, the synergy of using the industrial know-how and research experience allowed to sinter SMART rectangular samples with linear dimensions of 10 cm, thickness of 0.5 cm and a weight slightly below 1 kg. Density evolution of industrial-grade SMART materials demonstrated an outstanding progress, presently exceeding 97%.

Finally, the transition to industrial suppliers of the feedstock allowed SMART to outperform pure tungsten in powder procurement costs needed for plasma-facing components. Current status of industrial SMART technology will be presented along with outlook to future activities.