In this study, functional behavior of newly developed Co-base $Co_{49}Ni_{21}Ga_{30}$ and $Co_{38}Ni_{33}Al_{29}$ (in at. %) high-temperature shape memory alloys (HTSMAs) is reported. A thorough experimental program addressing the mechanical and functional properties of $Co_{49}Ni_{21}Ga_{30}$ and $Co_{38}Ni_{33}Al_{29}$ single crystalline alloys was executed in order to understand the effects due to crystallographic orientation and thermomechanical treatments.

The $Co_{38}Ni_{33}Al_{29}$ single crystals investigated in this work demonstrate a large pseudoelastic (PE) window of more than 250 °C, good cyclic stability and trainability with a maximum two-way shape memory effect (TWSME) strain of 2.7 %. The results emphasize the need for texturing polycrystalline aggregates of the current material near the <001> and <110> poles with an optimum γ-phase volume fraction to achieve high functional performance in $Co_{38}Ni_{33}Al_{29}$ alloys.

In as-grown $Co_{49}Ni_{21}Ga_{30}$ specimens, the low critical transformation stress due to the high resolved shear stress factor (RSSF) value, *i.e.* low Clausius-Clapeyron (CC) slope, high slip resistance in the austenite due to zero Schmid factor and B2 atomic ordering allow for excellent transformation recoverability with a large PE temperature range of about 325 °C when loaded in the [001] direction. The thermomechanical training resulted in a stable microstructure improving the transformation recoverability, which in turn resulted in a large PE window of 400 °C in the temperature range of 40-425 °C, and also in a stable cyclic behavior. In addition, the employed high-temperature aging treatments at 900 °C for 24 hours on $Co_{49}Ni_{21}Ga_{30}$ alloys brought about a stable cyclic stress-strain response at elevated temperatures as high as 300 °C. The martensite stabilization due to pinning of moving interfaces, detwinning and diffusion of point defects in $Co_{49}Ni_{21}Ga_{30}$ alloys especially at elevated temperatures (>120 °C) is macroscopically reflected by the shift of the unloading curve to lower stress levels and consequently resulted in a large stress hysteresis of about 350 MPa. Along with the *in-situ* microscopy, the spatial visualization of strain localization obtained by using digital image correlation (DIC) revealed heterogeneous transformation characteristics at temperatures below 120 °C, beyond which the nucleation and growth characteristics of SIM transformation are quasi-homogeneous resulting in a multi-variant configuration, which was later inherited by the trained crystal. An insight into the evolution of the microstructure and stress-strain behavior in terms of stress hysteresis with test temperatures is provided, and the possible operant mechanisms are presented.