COLD CONSOLIDATION OF THE AMORPHOUS NI-ZR-TI RIBBONS BY HIGH PRESSURE TORTION

T. Czeppe, G. Korznikova, A. Korneva (korneva_anna@mail.ru)
Institute of Metallurgy and Materials Science, Polish Academy of Sciences, Kraków

General abstract

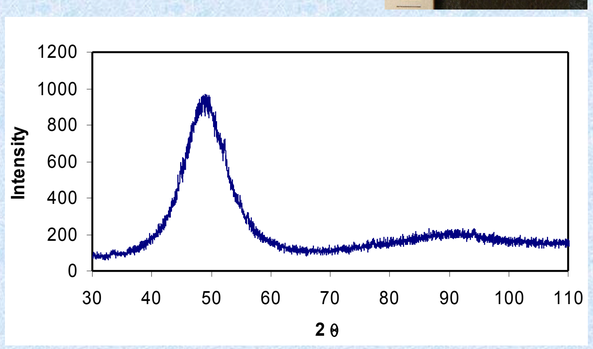
Metallic glasses are characterized by high elasticity, high hardness and may have high corrosion resistance depending on the composition. They should find a wide application in engineering if the problems with low deformability are solved. Until now the applications of these materials are limited by small sizes of industrial products (the thickness of the ribbons is commonly about 50-70 μm, the diameter of wires is about 100 μm).

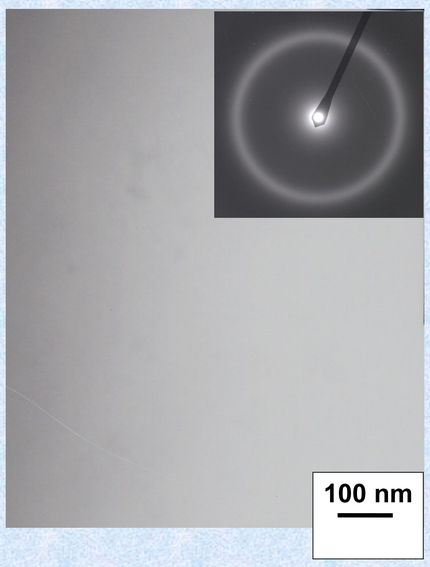
In this work the HPT at room temperature of amorphous melt spun ribbons was applied for bulk samples production.

Scientific abstract

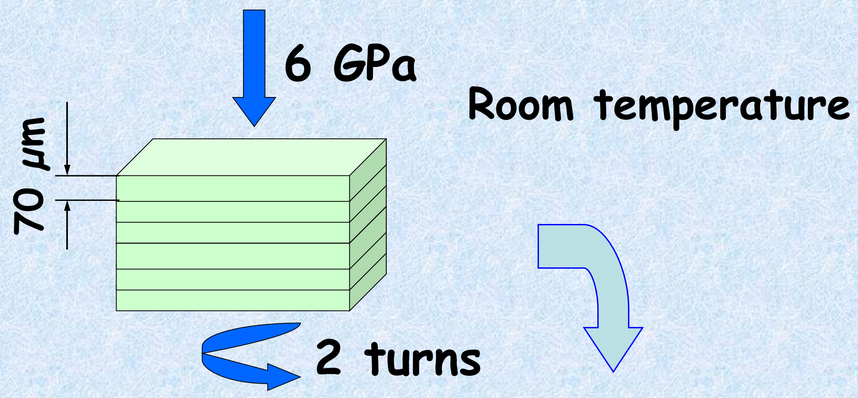
The cold consolidation of six parts of the amorphous ribbon of the composition $(Ni_{56}Cu_2)Zr_{18}Ti_{16}Al_3Si_5$ by HPT was applied for bulk samples production. The SEM was used to control the quality of the consolidation along the cross section. It was found that the consolidation was not complete in the center of the sample. The microstructure investigations of the good consolidated parts by X-ray analysis and by the TEM show that the sample partially crystallized, retaining predominantly an amorphous phase. The DSC method shows that the glass transition (T_g) and the primary crystallization temperatures (T_x) of the ribbon and of the CCS are similar, however the enthalpy change ΔHc for primary crystallization of the CCS is lowered by 10% in comparison with the ribbon. The thermal stability ΔT of the CCS is decreased. The maximal thickness of good consolidated part is about 400 μm.

X-ray pattern and TEM microstructure of the ribbon before HPT

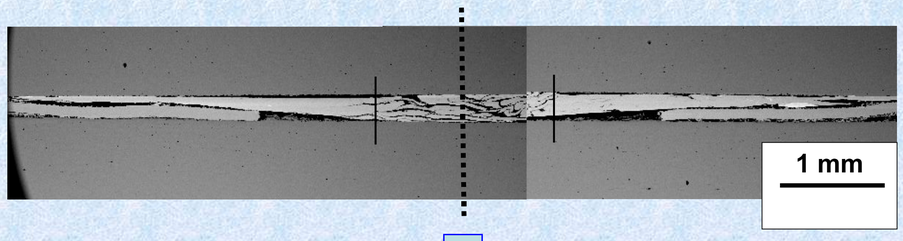




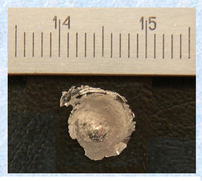
The scheme of HPT

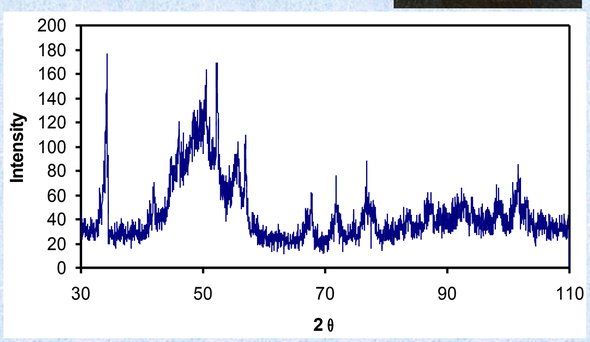


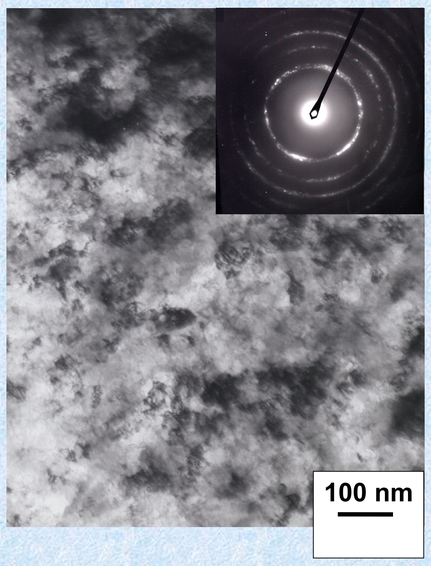
Cross-section through the sample after HPT, SEM



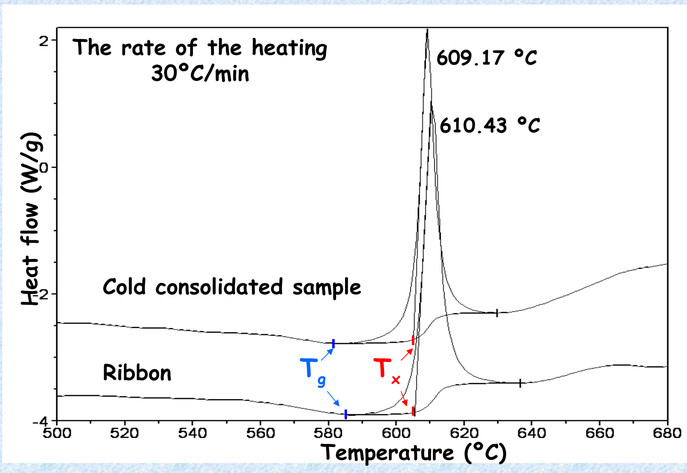
X-ray pattern and TEM microstructure of the sample after HPT







The DSC curves of the ribbon and the CCS



Samples	T_g, [°C]	T_x, [°C]	ΔT	$ΔH_c$, [J/g]
Ribbon	572	605,4	33,4	64,6
CCS	576	605,0	29,0	58,4

T_g - the glass transition temperature;
T_x - the primary crystallization temperatures;
ΔT - the thermal stability;
ΔHc - the enthalpy of primary crystallization.

Conclusions:

Cold consolidation of amorphous ribbons by the HPT resulted in the partially crystallization of the sample (about 10%).

Cold consolidation was not complete in the sample center. It is possible that the application of largest turns will allow to achieve the full consolidation.

The maximal width of consolidated part was about 400 μm.

Glossary:

HPT – high pressure torsion;

SEM - scanning electron microscopy;

TEM – transmission electron microscopy;

DCS - differential scanning calorimeter;

CCS – cold consolidated sample.