**Introduction and motivations**

- Platinum is one of the three precious metals mostly used in the jewelry and watch making industry for its aesthetic appearance and its corrosion resistance. But hallmarking standards limit the degree of substitution of platinum and crystalline platinum alloys scratch resistance and process ability still can be improved.
- Platinum-based bulk metallic glasses alloys show high strength, high hardness and low melting point.
- Bulk metallic glasses (BMGs) are metals with a disordered structure obtained with high cooling rate to avoid the crystallization nose in the TTT diagram (1).
- BMGs exhibit a glass transition temperature and have a supercooled liquid region (SCLR) which offers the possibility of thermoplastically form (TPF) the material like polymers (2).
- Pt-based BMGs are found near “deep eutectic” compositions to lower the melting point.
- The alloy was cast with an amorphous structure by arc melting in quartz tubes at a heating rate of 20 K/min between 330°C and 340°C.
- In-situIsothermal DSC measurements showed that up to 340°C more than 5 minutes are available for TPF up to 340°C.
- The alloy has a good formability in its SCLR and can be thermoplastically formed in air without risk of oxidation.
- Thermophysical properties remained mostly stable with varying the thermoplastic forming temperature.
- T>M is slightly decreased and ΔT>M is reduced by increasing the TPF temperature.
- The alloy should be ductile and have a higher formability.
- There is a contradiction between the fracture toughness results and the G/B ratio. The alloy should be ductile and have a higher Kc.
- There is a contradiction between the facture toughness results and the G/B ratio. The alloy should be ductile and have a higher Kc. The defects embedded in the matrix might embrittle the alloy by interacting with the shear bands. Removing the defects might improve the alloy. 

**Methods**

- **Pt_{49.95}Si_{16.65}B_{24}Cu_{16.65}Ge_{3}** was melted by induction in quartz tubes.
- The alloy was cast with an amorphous structure by arc-melting and suction casting in water cooled copper molds.
- Thermoplastic forming at 320, 330 and 340°C.
  - Preheating step of 15 s
  - 2 forming steps: (i) 17.5 kN for 1 min, (ii) 7.5 kN for 2 min.
- Thermoplastic forming at 330°C to shape samples for tensile and fracture toughness tests.
- Replication of a silicon mold.
- Molds fabricated by Si photolithography combined with ion etching.

**Formability test**

- Method based on a paper from Jan Schroers.
- Samples of 100 mm³ loaded with 4.5 kN at a heating rate of 20 K/min between T>T>M and T>M.
- Formability characterized by the final diameter of the deformed sample.
- The surface of the sample after the test allows to know if the alloy oxidizes during TPF.
- Results:
  - Average final diameter of 20.8±0.8 mm: good formability.
  - Metallic surface after the test resistant to oxidation.

**Isothermal DSC measurements**

- Allows to know the time to crystallization when heating in the SCLR.
- τ_crystal = 0 considered at 98% of τ_melt, at 365°C.
- More than 5 minutes available for TPF up to 340°C.
- The higher the temperature, the lower the viscosity and the τ_melt but also the smaller the thermoplastic forming time.

**Electron microscopy**

- Two kinds of defects randomly distributed in the alloy: (i) boron rich phases, (ii) voids.
- Oxygen is everywhere in the alloy.
- Defects are surrounded by phases rich in germanium, boron, silicon and oxygen.
- Possible change of the alloy composition.

**Mechanical properties**

- Hardness of the as-cast alloy ≈ 575 Hv.
- Hardness slightly increases with the TPF temperature.
- Ultimate tensile strength: 1260 MPa.
- Fracture toughness intensity factor Kc=36.4±10.7 MPa.m^1/2.
- G/B and Poisson’s ratios: 0.19 and 0.41.
  - The alloy should be ductile.
  - Possible embrittlement of the alloy due to the defects embedded in the glassy matrix.

**Conclusions**

- The alloy has a good formability in its SCLR and can be thermoplastically formed in air without risk of oxidation.
- Isothermal DSC measurements showed that up to 340°C more than 5 minutes are available for thermoplastic forming.
- SEM and TEM measurements revealed the presence of two kinds of defects surrounded by possible oxide phases in the alloy.
- Thermophysical properties remained mostly stable with varying the thermoplastic forming temperature.
- The hardness remained almost the same after TPF with a very high value of 575 Hv.
- There is a contradiction between the facture toughness results and the G/B ratio.
  - The alloy should be ductile and have a higher Kc.
  - The defects embedded in the matrix might embrittle the alloy by interacting with the shear bands.
  - Removing the defects might improve the alloy.