Tensile Properties of Ag Alloy Clad Bi-2212 Round Wires

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Outline

- Material Description
- Tensile Test Plan
- Conventional Data Analysis vs Superconductor Specific Analysis
- Effect of material condition and test temperature on Stress-Strain behavior
- Conclusions

Material Description:

Composite HTS Superconductor Round Wire

Manufacturer: OST

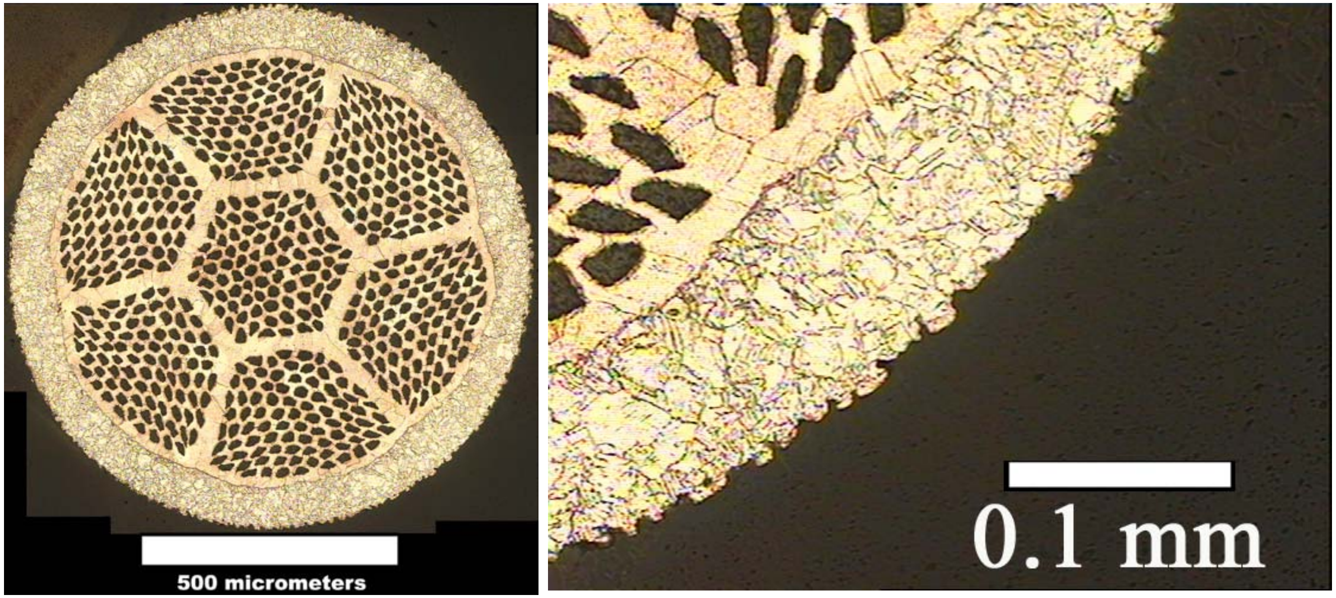
Production Method: PIT

Components: Ag/AgMg/Bi-2212

Dia. = 1.03 mm

Material Conditions:

1. "As Received (AR)" = unreacted with manufacture anneal
2. "Annealed" = AR+ 350C/1h- Ar Atmosphere
   anneal performed at NHMFL
3. "Reacted "= Conventional OST HT for Bi2212
   HT performed at NHMFL



AR+Annealed wire.Sample etched in 25mlNH_4OH+15ml 30%H_2O_2.

Tensile Test Plan

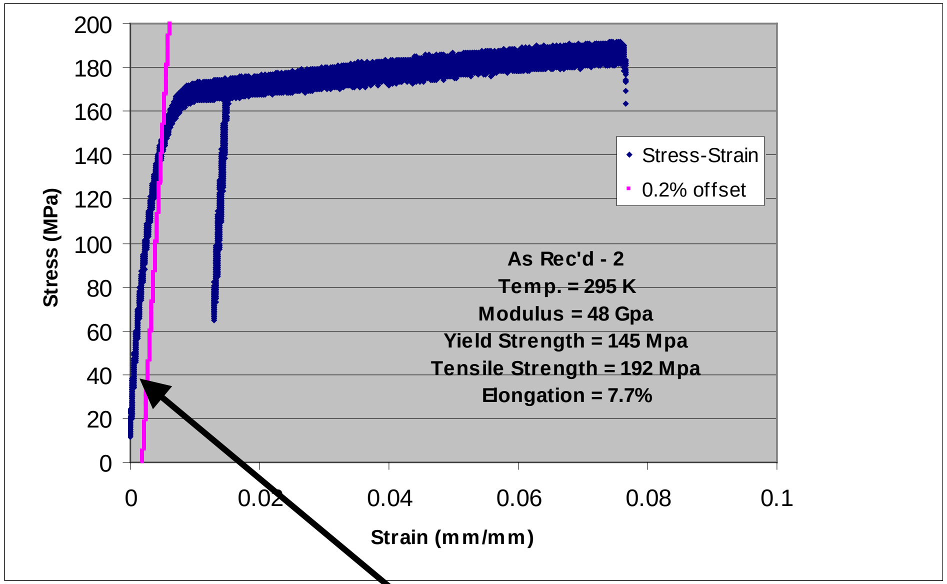
Objectives:

1. Generate tensile data on Bi-2212 composite wires
2. Develop improved test and analysis techniques

Method:

- Displacement control tensile tests
  - 2.5 kN Load Cell
  - 25 mm gage length Extensometer
- Test material conditions:
  - AR (Un-reacted)
  - AR+ Annealed (Un-reacted)
  - Reacted Condition
- Test Temperatures:
  - 295 K, 77 K, 4 K
- Analyze and compare results

295 K Tensile Results for Un-reacted Wire
Conventional Tensile Test Analysis



For structural materials
Conventional analysis is used to determine:
- **Youngs Modulus**
- **Yield Strength**
- **Tensile Strength**
- **Strain to Failure**

Mat'l: Bi-2212, as received condition

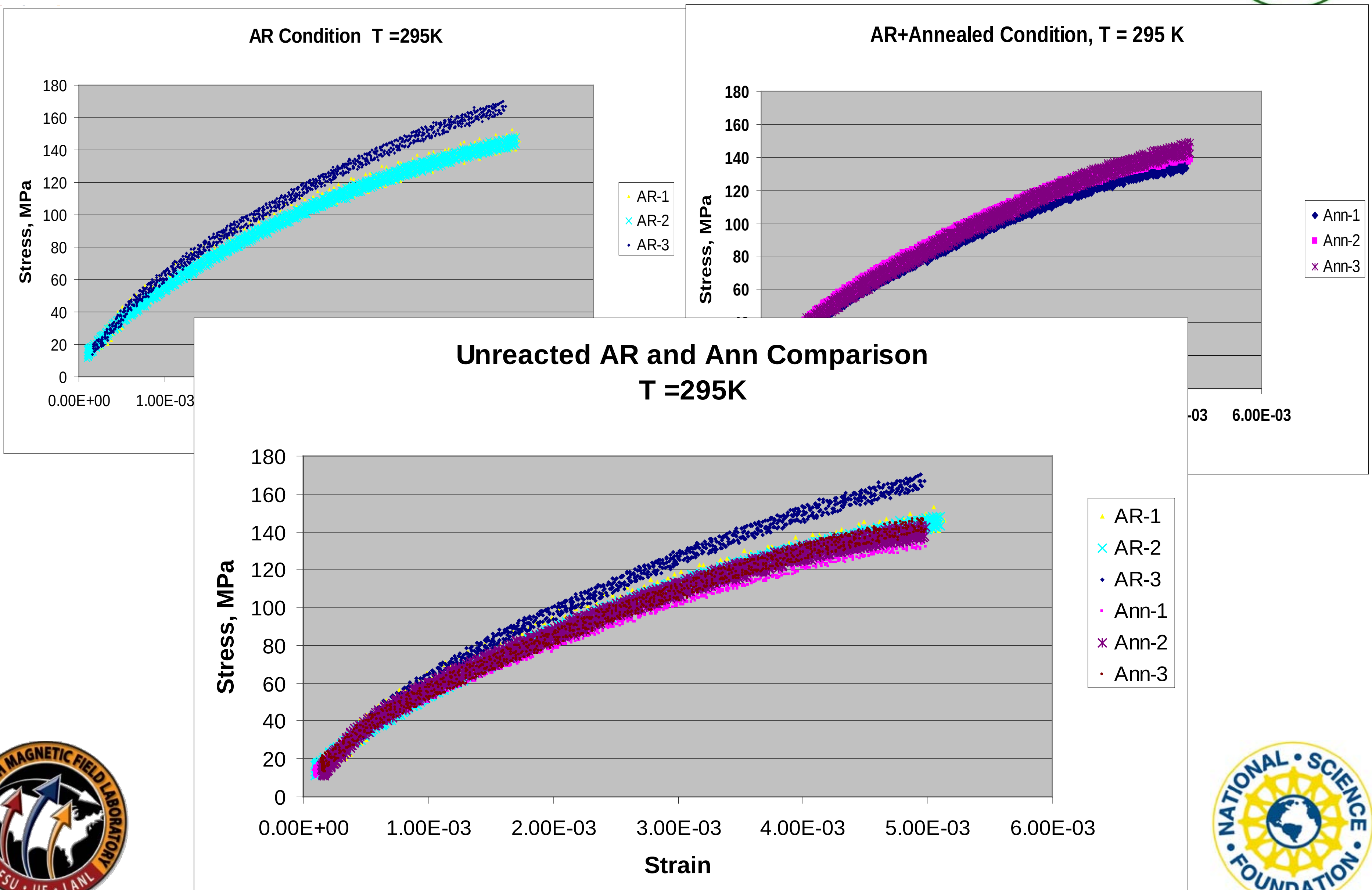
Specimen No.	Modulus (GPa)	Yield Strength (MPa)	Tensile Strength (MPa)	Elongation (%)
As Rec'd - 1	51	122	175	6.5
As Rec'd - 2	48	145	192	7.7
As Rec'd - 3	48	145	192	7.3
average	***49***	***137***	***186***	***7.2***
stand. dev.	***1.7***	***13.3***	***9.8***	***0.6***

Mat'l: Bi-2212, annealed by NHMFL

Specimen No.	Modulus (GPa)	Yield Strength (MPa)	Tensile Strength (MPa)	Elongation (%)
Anneal - 1	45	135	174	7.8
Anneal - 2	46	152	182	8.4
Anneal - 3	45	148	193	9.2
average	***45***	***145***	***183***	***8.5***
stand. dev.	***0.6***	***8.9***	***9.5***	***0.7***

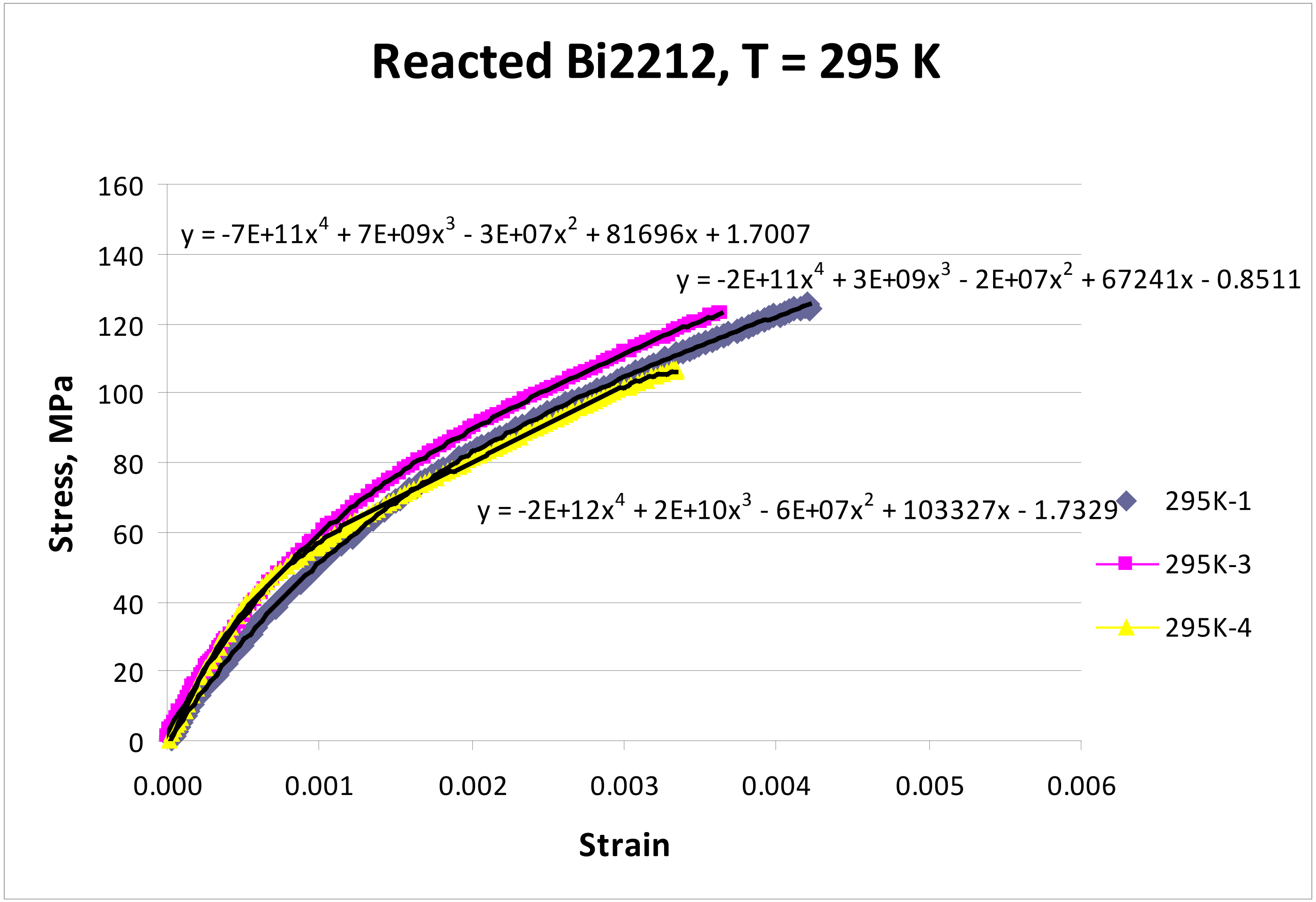
For Superconductors we are interested in the early portion of the stress strain curves because this is where the limit of materials usefulness in design is. (< 0.2% Strain Yield)

Analysis early portion of 295 K
Un-reacted Bi-2212 Stress-Strain Curves

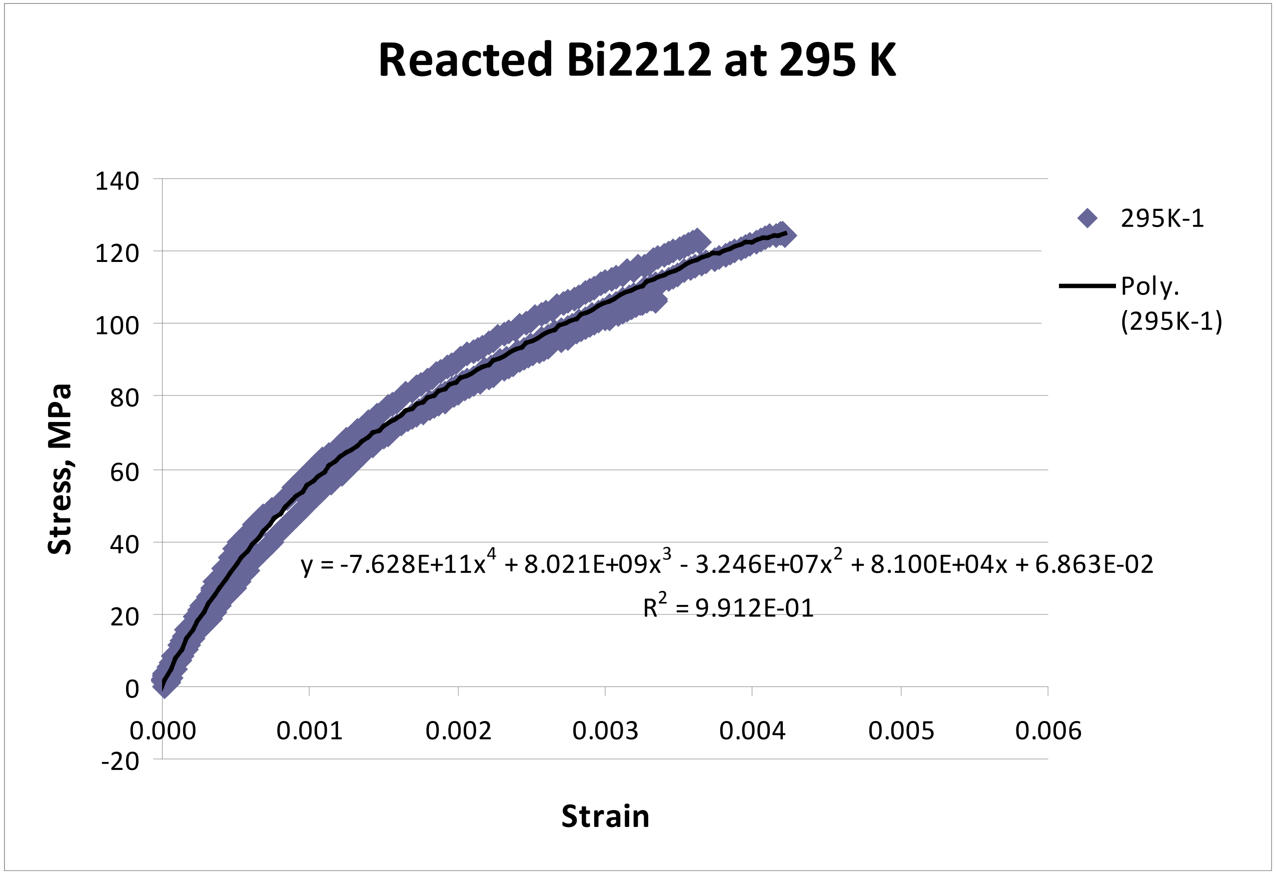


Comparison of the early portion of the σ-ε for 3 tensile tests of reacted wire

Stress-Strain Curves can be curve fit with polynomial or power function

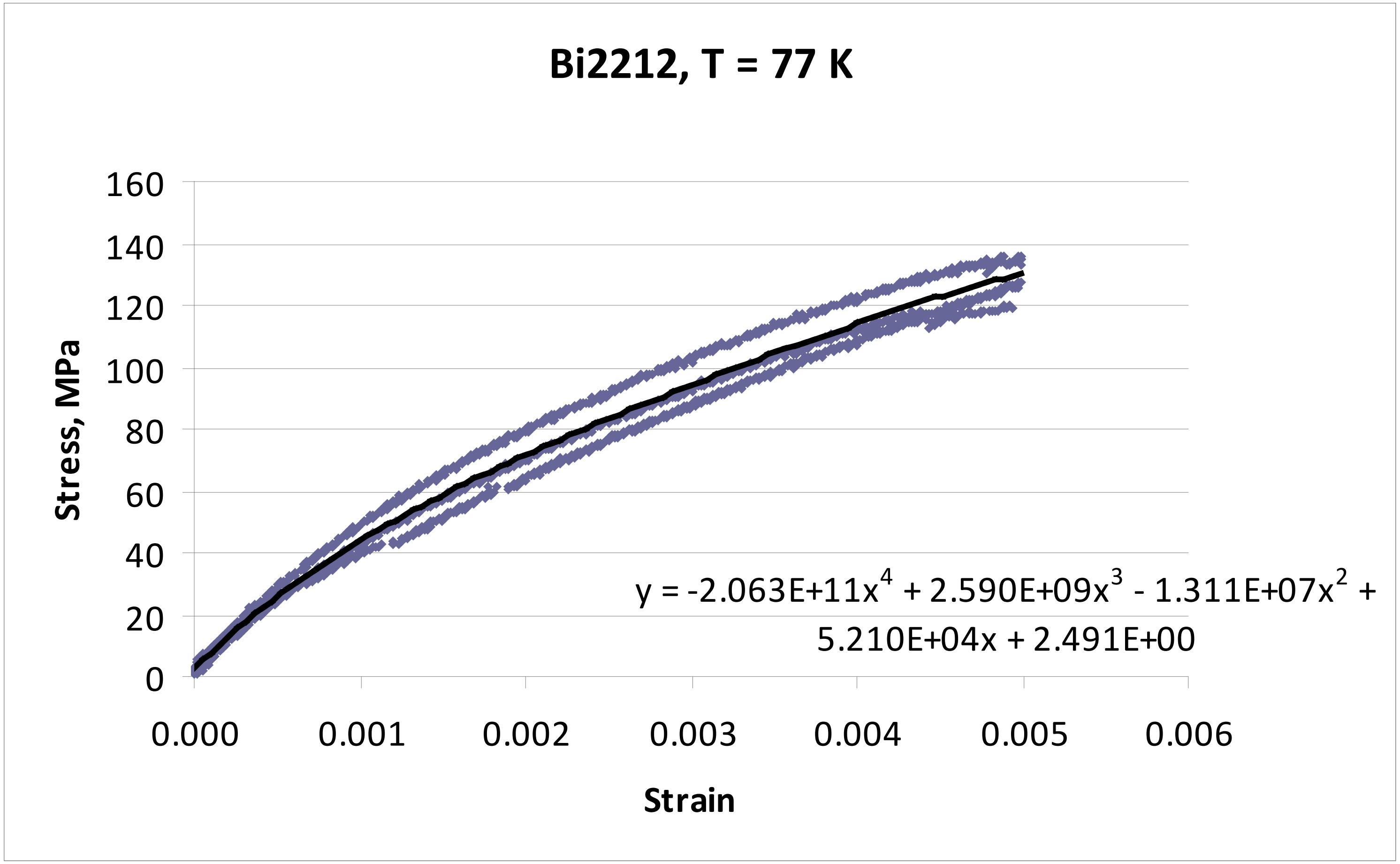


The Data for the 3 Stress-Strain Curves are combined and curve fit to obtain an average

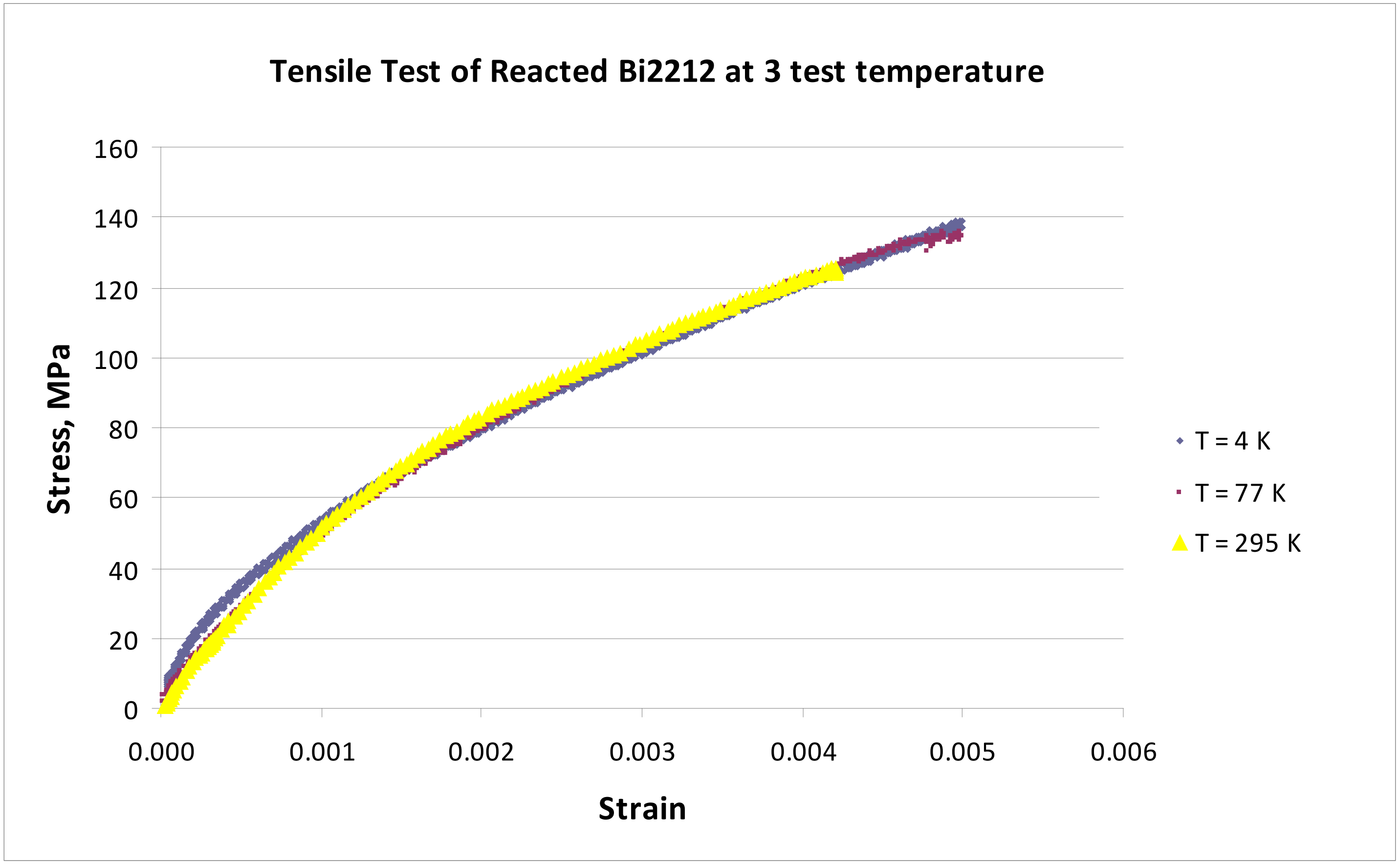


But what good is 295 K data when the wire is used in a cryogenic application ?

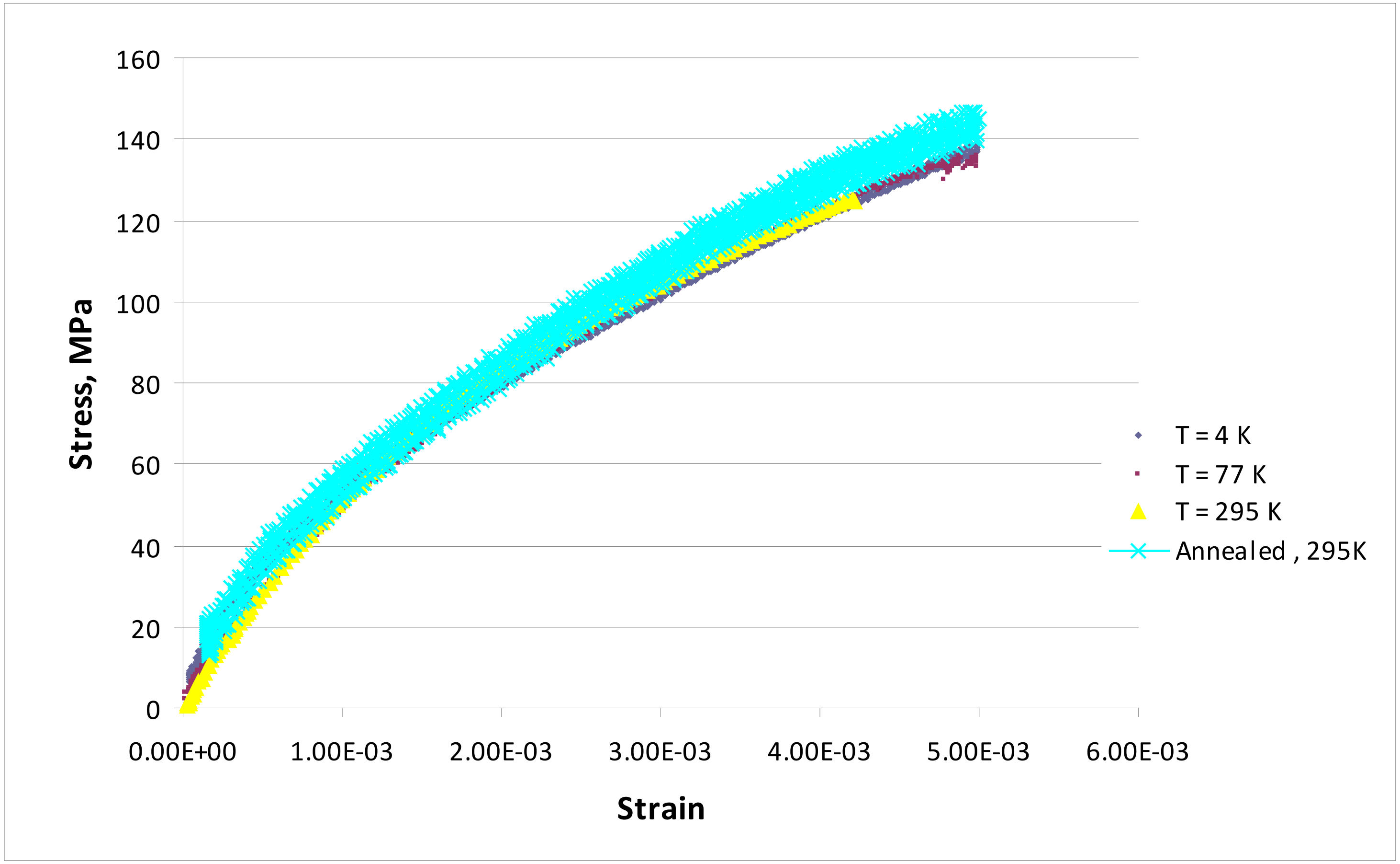
The same data analysis treatment is applied to 3 test run at 77 K



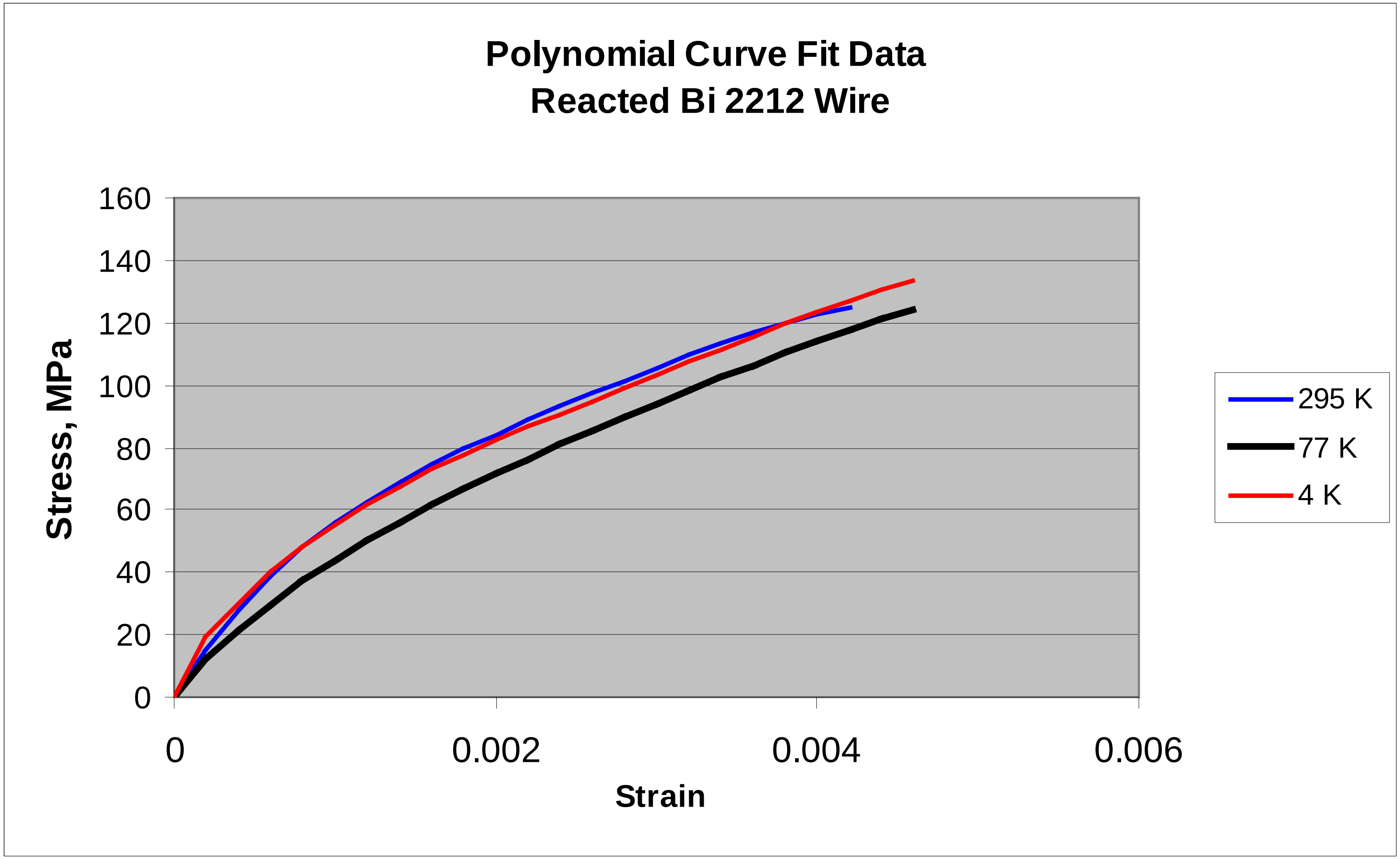
Plots of 3 individual tensile tests run at the 3 test temperatures Surprisingly indicate NO Obvious temperature dependance



Inclusion of the un-reacted wire tensile data indicates the Stress-strain behavior is NOT affected by material condition or test temperature



Comparison of the average stress-strain as described by the curve fits shows anomalous temperature dependence



CONCLUSIONS :

1. Tensile tests have been performed to;
   - generate engineering design data
   - help understand the influence of material processing
   - understand temperature dependence of the mechanical properties.

2. Careful tests methods and data analysis techniques have been developed and used to characterize the HTS superconductor.

3. The 295 K properties of “un-reacted annealed wire”
   are about the same
   as the “reacted wire”

4. A temperature dependence of stress-strain behavior is not evident with these tests conducted at 295, 77 and 4 K.