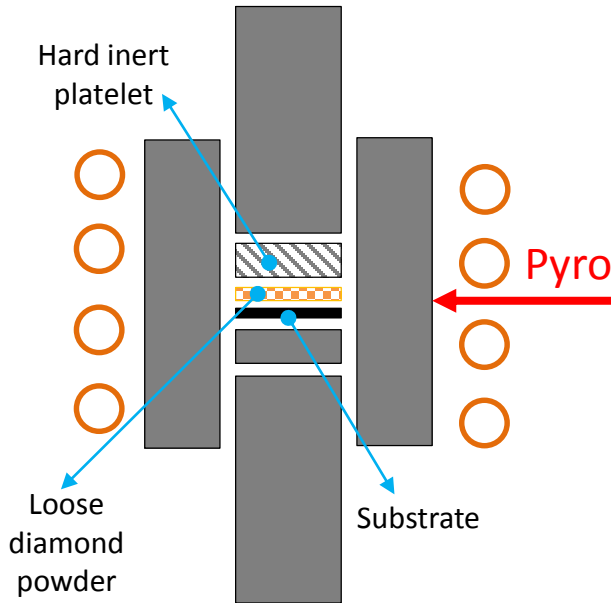


Task 17.5 - Development of new diamond based composites for luminescence screens

David Grech








- ▀ Embedding of diamond particles onto metallic substrates
- ▀ Diamonds will act as scintillators upon excitation/relaxation from incident high energy beam
- ▀ Requirements:
 - ▀ Smaller the diamond particle size -> the higher the resolution of the incident beam
 - ▀ Smaller the Z-number of the substrate -> lesser interaction between high energy beam and substrate material
 - ▀ Tougher substrate -> higher resistance to induced heat / sputtering damage







- Sample size: Dm20mm Height 1mm
- Substrate materials: Ti, Ti6Al4V, TiAl, Ti composites, Al alloys
- Diamond powders: 45/20-30/6-10/1-3 μm
- Diamond type/purity: yet to be investigated
- Induction hotpress: Graphite die, uniaxial pressure, pyrometer control, under vacuum
- Die preparation
 - Use of hard inert material to force diamonds into softer substrate
 - Use least amount of diamonds
 - Variation of temperature/time/holding time
 - Process optimisation

Processing

-  Homogeneous distribution
-  Amount of diamonds to be added
-  Substrate mechanical properties
-  Substrate reactivity with diamonds
-  Adhesion of diamonds to substrates

Parameters

-  Softening of substrate material
-  Graphitisation of diamonds, catalysed by carbide forming elements
-  Holding time
-  Contamination of exposed diamond surface



IHP5140 – Dia45 on Ti6Al4V



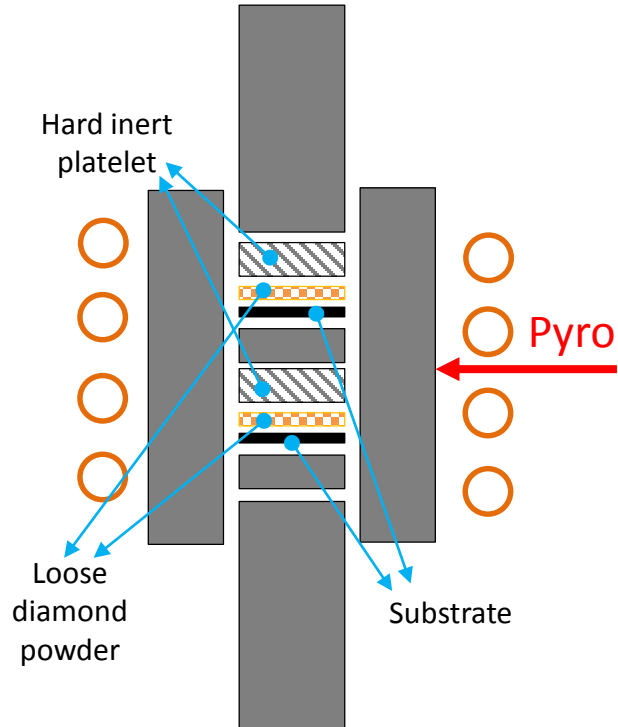
IHP5142 – Dia45 on TiAl



IHP5136 – Dia45 on Ti



IHP5138 – Dia45 on Ti6Al4V



- Sample size: Dm20mm Height 1mm
- 1x Ti, 1x Ti6Al4V substrates
- Same processing conditions
- Diamond 45 μm MBD8 quality
- Homogenised the surface finish of substrates and hard platelet



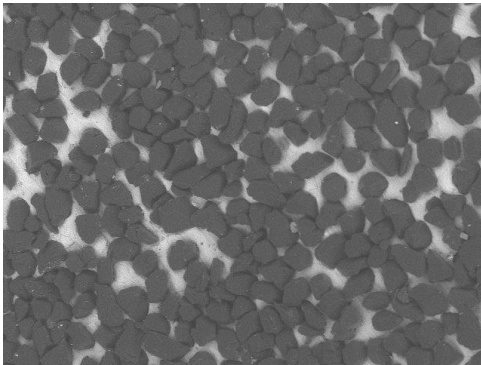
IHP5231-A
900°C/5min/30MPa



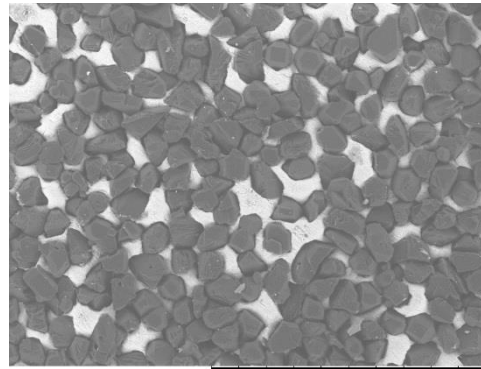
IHP5232-A
900°C/15min/30MPa



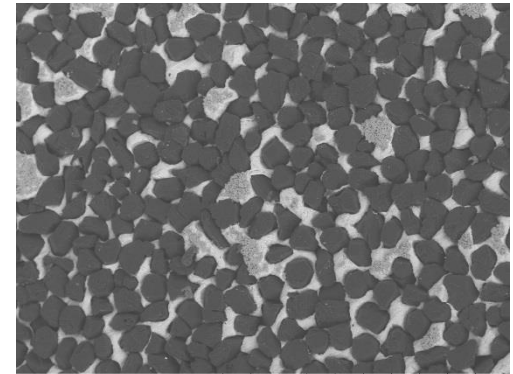
IHP5233-A
900°C/30min/30MPa



REM-170061 2017.09.26 03:58 L D4.0 x200 500 um
AA17274 IHP5231 Dia45+TiGd2 EA

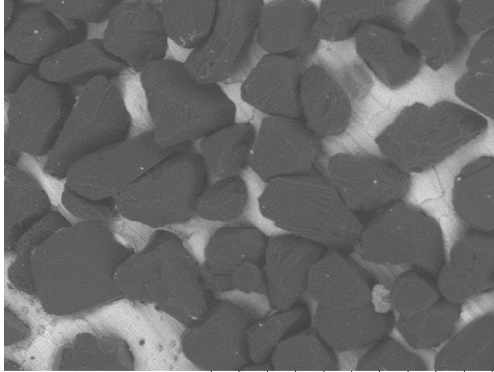


REM-170027 2017/09/22 09:39 L D2.0 x200 500 um
AA17274 IHP5232 TiGd2+Dia EA

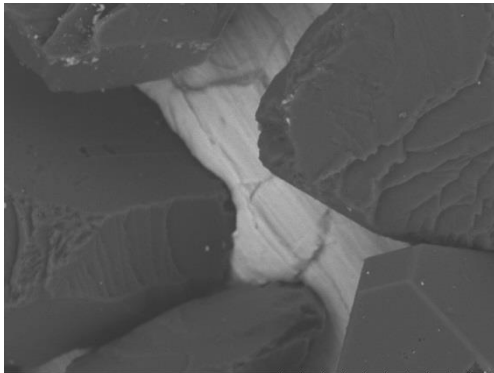


REM-170095 2017.09.26 08:09 L D3.4 x200 500 um
AA17274 IHP5233 Dia45+TiGd2 EA

IHP5231-A
900°C/5min/30MPa

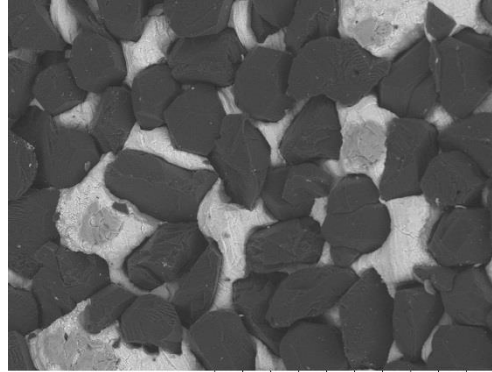


REM-170062 2017.09.26 04:00 L D4,0 x500 200 um
AA17274 IHP5231 Dia45+TiGd2 EA

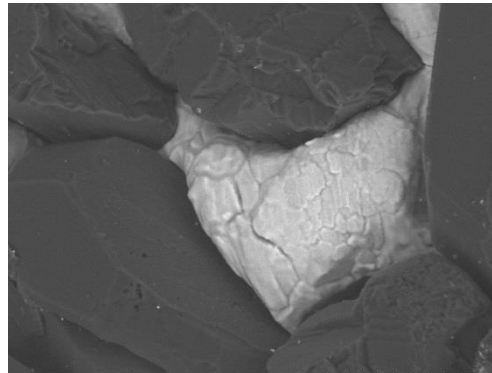


REM-170071 2017.09.26 05:23 L D3.7 x2.5k 30 um
AA17274 IHP5231 Dia45+TiGd2 EA

IHP5232-A
900°C/15min/30MPa

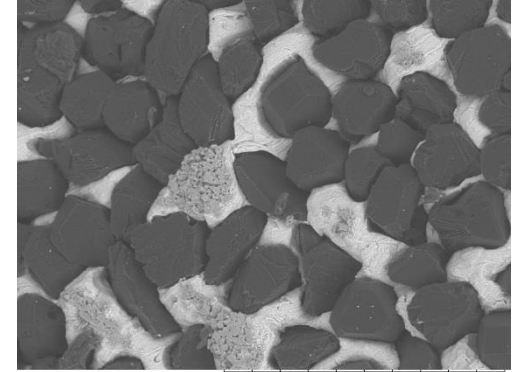


REM-170087 2017.09.26 07:41 L D3.6 x500 200 um
AA17274 IHP5232 Dia45+TiGd2 EA

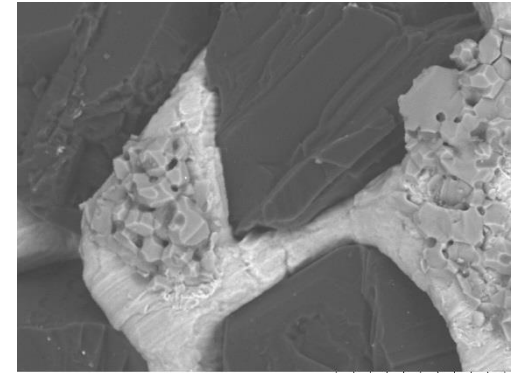


REM-170083 2017.09.26 07:25 L D3.7 x2.0k 30 um
AA17274 IHP5232 Dia45+TiGd2 EA

IHP5233-A
900°C/30min/30MPa



REM-170096 2017.09.26 08:10 L D3.4 x500 200 um
AA17274 IHP5233 Dia45+TiGd2 EA



REM-170098 2017.09.26 08:13 L D3.2 x2.0k 30 um
AA17274 IHP5233 Dia45+TiGd2 EA



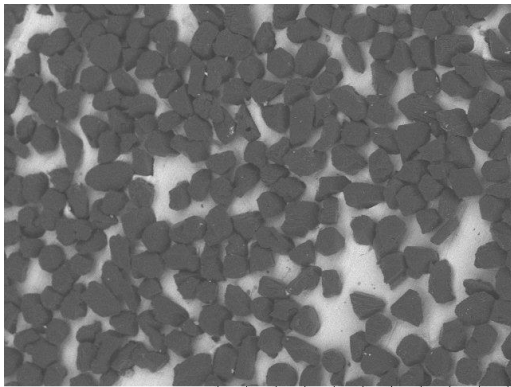
IHP5231-B
900°C/5min/30MPa



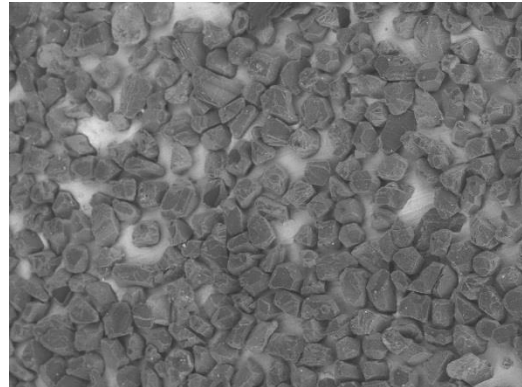
IHP5232-B
900°C/15min/30MPa



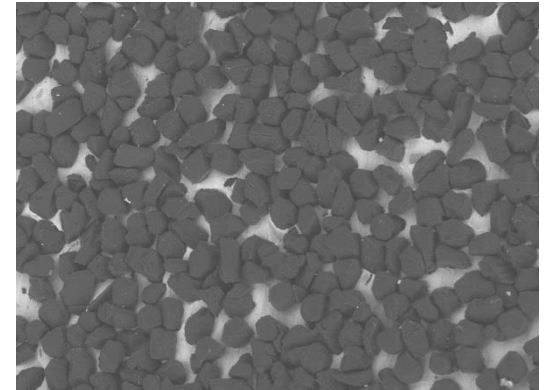
IHP5233-B
900°C/30min/30MPa



REM-170073 2017.09.26 05:34 L D3.5 x200 500 um
AA17274 IHP5231 Dia45+TiGd5 EA

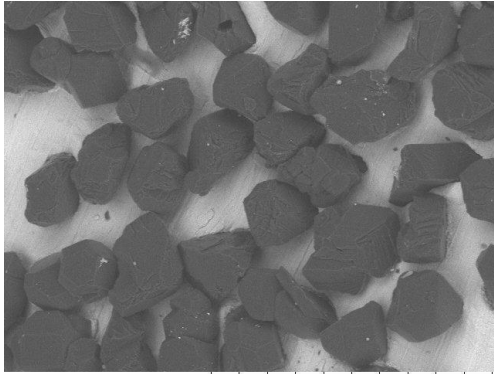


REM-170089 2017.09.26 07:49 L D3.3 x200 500 um
AA17274 IHP5232 Dia45+TiGd5 EA

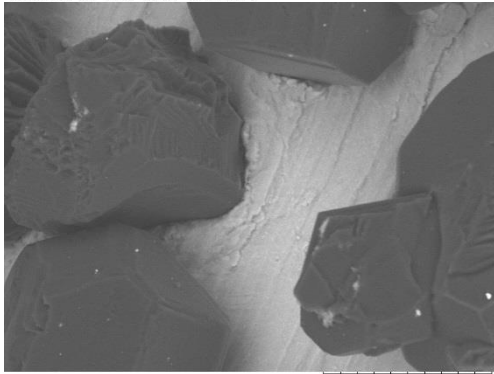


REM-170102 2017.09.26 08:29 L D3.6 x200 500 um
AA17274 IHP5233 Dia45+TiGd5 EA

IHP5231-B
900°C/5min/30MPa

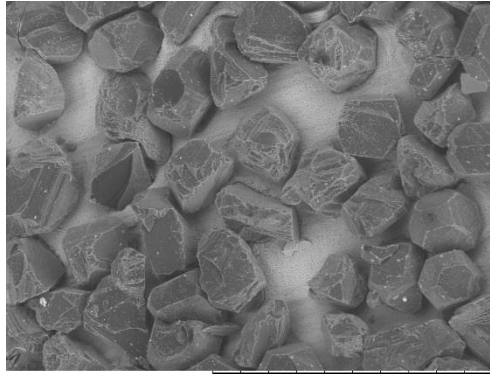


REM-170074 2017.09.26 05:36 L D3.7 x500 200 um
AA17274 IHP5231 Dia45+TiGd5 EA

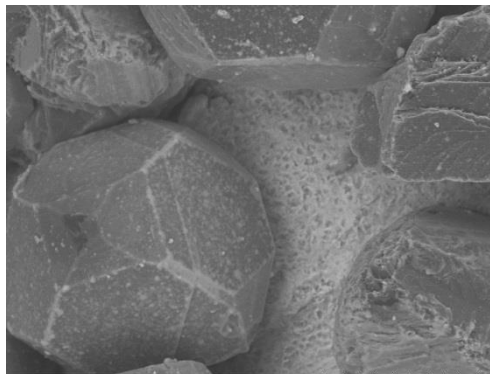


REM-170076 2017.09.26 05:39 L D3.6 x2.0k 30 um
AA17274 IHP5231 Dia45+TiGd5 EA

IHP5232-B
900°C/15min/30MPa

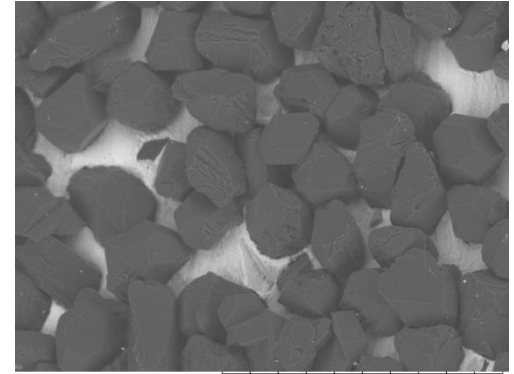


REM-170090 2017.09.26 07:51 L D3.5 x500 200 um
AA17274 IHP5232 Dia45+TiGd5 EA

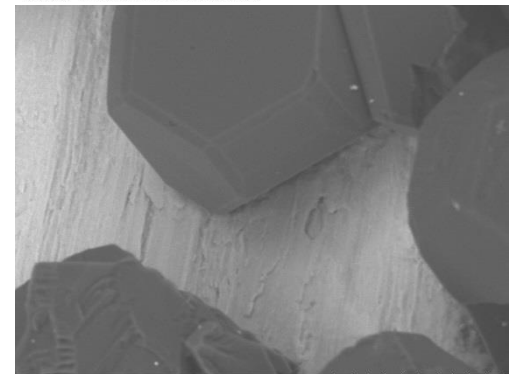


REM-170092 2017.09.26 07:53 L D3.4 x2.0k 30 um
AA17274 IHP5232 Dia45+TiGd5 EA

IHP5233-B
900°C/30min/30MPa



REM-170103 2017.09.26 08:30 L D3.4 x500 200 um
AA17274 IHP5233 Dia45+TiGd5 EA



REM-170105 2017.09.26 08:32 L D3.6 x2.0k 30 um
AA17274 IHP5233 Dia45+TiGd5 EA

- ▮ Smaller diamond fractions -> Nanodiamonds??
- ▮ Test further substrate materials
- ▮ Diamond particles characterisation
- ▮ Improve diamond embedding into substrate
- ▮ Thinner substrates
- ▮ Improve diamond distribution
- ▮ Custom particle surface density