```
<!-- ************************************************************* -->
<!-- MatML DTD Version 2.0                                         -->
<!--    This is a working draft and should not be considered an    -->
<!--    official recommendation or standard.                       -->
<!--                                                               -->
<!--    29 March 2001                                              -->
<!--    Prepared by E.F. Begley (begley@nist.gov) on behalf of the  -->
<!--    MatML Working Group.                                       -->
<!-- ************************************************************* -->

<!-- ************************************************************* -->
<!--                PRINCIPLE ELEMENT DECLARATIONS                 -->
<!-- ************************************************************* -->

<!ELEMENT MatML_Doc (Material+)>

<!ELEMENT Material (BulkDetails,
                    ComponentDetails?,
                    Terms?,
                    Graphs?)>

<!ELEMENT BulkDetails (Name,
                       Class?,
                       Subclass*,
                       Specification*,
                       Source?,
                       Form?,
                       Processing?,
                       Geometry?,
                       Characterization?,
                       Properties?,
                       Notes?)>
<!ATTLIST BulkDetails %xmlns;>

<!ELEMENT ComponentDetails (Name,
                            Class?,
                            Subclass*,
                            Specification*,
                            Source?,
                            Form?,
                            Processing?,
                            Geometry?,
                            Characterization?,
                            Properties?,
                            Associations?,
                            Notes?)+>
<!ATTLIST ComponentDetails %xmlns;>

<!ENTITY % VHG SYSTEM "http://www.vhg.org.uk/dtd/vhgdtd.html">
<!ELEMENT Terms (%VHG;)>
<!ATTLIST Terms %xmlns;>

<!ENTITY % SVG PUBLIC "-//W3C//DTD SVG 20001102//EN"
"http://www.w3.org/TR/2000/CR-SVG-20001102/DTD/svg-20001102.dtd">
<!ELEMENT Graphs (%SVG;)>
<!ATTLIST Graphs %xmlns;>
```

```
<!-- ************************************************************** -->
<!--  ALPHABETIZED ELEMENT DECLARATIONS USED IN PRINCIPLE ELEMENTS  -->
<!-- ************************************************************** -->

<!ELEMENT Associate (#PCDATA)>

<!ELEMENT Associations (Associate,
                        Relationship,
                        Notes?)+>
<!ATTLIST Associations %xmlns;>

<!ELEMENT Characterization (Formula,
                            ChemicalComposition?,
                            PhaseComposition?,
                            DimensionalDetails?,
                            Notes?)>
<!ATTLIST Characterization %xmlns;>

<!ELEMENT ChemicalComposition ((Compound|Element),
                               Concentration,
                               Units,
                               Qualifier?,
                               Notes?)+>
<!ATTLIST ChemicalComposition %xmlns;>

<!ELEMENT Class (#PCDATA)>

<!ELEMENT Compound (Element,
                    Units)+>

<!ELEMENT Concentration (#PCDATA)>
<!ATTLIST Concentration %type;>

<!ELEMENT DataSource (#PCDATA)>
<!ATTLIST DataSource %xmlns;>

<!ELEMENT DataType (#PCDATA)>

<!ELEMENT DimensionalDetails (Name,
                              Value,
                              Units,
                              Qualifier?,
                              Notes?)+>
<!ATTLIST DimensionalDetails %xmlns;>

<!ELEMENT Dimensions (#PCDATA)>

<!ELEMENT Element (#PCDATA)>

<!ELEMENT Form (#PCDATA)>

<!ELEMENT Formula (#PCDATA)>

<!ELEMENT Geometry (Shape,
                    Dimensions?,
                    Orientation?,
                    Notes?)>
```

```
<!ATTLIST Geometry %xmlns;>

<!ELEMENT MeasurementTechnique (Name,
                                Notes?)>

<!ELEMENT Name (#PCDATA)>
<!ATTLIST Name %authority;>

<!ELEMENT Notes (#PCDATA)>

<!ELEMENT Orientation (#PCDATA)>

<!ELEMENT Parameters (Name,
                      Value,
                      Units,
                      Qualifier?
                      Notes?)+>
<!ATTLIST Parameters %xmlns;>

<!ELEMENT PhaseComposition (Name,
                            Concentration,
                            Units,
                            Qualifier?,
                            Properties?,
                            Notes?)+>
<!ATTLIST PhaseComposition %xmlns;>

<!ELEMENT Processing (Name,
                      Parameters?,
                      Result?
                      Notes?)+>
<!ATTLIST Processing %xmlns;>

<!ELEMENT Properties (PropertyDetails,
                      Value,
                      Qualifier?,
                      Parameters?)+>
<!ATTLIST Properties %xmlns;>

<!ELEMENT PropertyDetails (Name,
                           Units,
                           DataSource,
                           DataType,
                           MeasurementTechnique?,
                           Notes?)>
<!ATTLIST PropertyDetails %xmlns;>

<!ELEMENT Qualifier (#PCDATA)>

<!ELEMENT Relationship (#PCDATA)>

<!ELEMENT Result (#PCDATA)>

<!ELEMENT Shape (#PCDATA)>

<!ELEMENT Source (#PCDATA)>
```

```
<!ELEMENT Specification (#PCDATA)>
<!ATTLIST Specification %authority;>

<!ELEMENT Subclass (#PCDATA)>

<!ELEMENT Units (#PCDATA)>
<!ATTLIST Units %authority;>

<!ELEMENT Value (#PCDATA)>
<!ATTLIST Value %type;>

<!-- ************************************************************** -->
<!--          ALPHABETIZED PARAMETER ENTITY DECLARATIONS            -->
<!-- ************************************************************** -->

<!ENTITY % authority "authority CDATA #IMPLIED">
<!ENTITY % type "type (text | integer | float) #REQUIRED">
<!ENTITY % xmlns "xmlns CDATA #IMPLIED">

<!-- ************************************************************** -->
<!--                    END OF FORMAL MatML DTD                     -->
<!-- ************************************************************** -->
```

```
***********************************************************************
    COMMENTARY AND SAMPLE MARKUP FOR PRINCIPLE ELEMENT DECLARATIONS
***********************************************************************
```

```
<!ELEMENT MatML_Doc (Material+)>
```

This statement declares the content model for MatML_Doc, topmost in the hierarchy of elements that comprise a document marked up using MatML. Content models describe the relationships of the element and its child elements and/or textual content. Here, the declaration for MatML_Doc says that it must contain one or more Material elements.

Note

The Material element has an appended + sign. The + is one of several indicators in XML DTD's.

1. + means the element must occur one or more times.
2. ? means the element can appear once or not at all.
3. * means the element can appear zero or more times.
4. If there is no indicator present it means the element must appear once and only once.

Sample Markup for MatML_Doc

```
<MatML_Doc>
      <Material>
            ...
      </Material>
      <Material>
            ...
      </Material>
</MatML_Doc>
```

Note
In this and subsequent markup samples, the ellipsis, ... , is used to indicate where additional markup, if necessary, is placed.

****

```
<!ELEMENT Material (BulkDetails,
                    ComponentDetails?,
                    Terms?,
                    Graphs?)>
```

This statement declares the content model for Material, which is composed of the following elements.

BulkDetails contains a description of the bulk material and has one optional attribute, xmlns, for namespace linking to alternative content models for BulkDetails.
Must occur once and only once.

ComponentDetails contains a description of the components that comprise the bulk material and has one optional attribute, xmlns, for namespace linking to alternative content models for ComponentDetails.
ComponentDetails might be used, for example, to describe the base metal, the heat affected zone, and the weld metal of a welded material or the whiskers, fibers, and matrix of a fiber-reinforced composite material, etc.
May occur once or not at all.

Terms contains descriptions of the material and property terms used in the document and has one optional attribute, xmlns, for namespace linking to alternative content models for Terms.
May occur once or not at all.

Graphs contains two-dimensional graphical images and has one optional attribute, xmlns, for namespace linking to alternative content models for Graphs.
May occur once or not at all.

Sample Markup for Material

```
<MatML_Doc>
      <Material>
            <BulkDetails>
                  See Sample Markup for BulkDetails
            </BulkDetails>
            <ComponentDetails>
                  See Sample Markup for ComponentDetails
            </ComponentDetails>
            <Terms>
                  See Sample Markup for Terms
            </Terms>
            <Graphs>
                  See Sample Markup for Graphs
            </Graphs>
      </Material>
</MatML_Doc>
```

****

```
<!ELEMENT BulkDetails (Name,
                       Class?,
                       Subclass*,
                       Specification*,
                       Source?,
                       Form?,
                       Processing?,
                       Geometry?,
                       Characterization?,
                       Properties?,
                       Notes?)>
<!ATTLIST BulkDetails %xmlns;>
```

The first statement declares the content model for BulkDetails while the second statement declares an optional attribute for BulkDetails called xmlns. The xmlns attribute is used to link to alternative content models for BulkDetails.

BulkDetails contains a description of the bulk material and is composed of the following elements.

Name contains the material's name and has one optional attribute, authority, for namespace linking to authoritative sources of material names.
Must occur once and only once.

Class contains the material's class.
May occur once or not at all.

Subclass contains the material's subclass(es).
May occur zero or more times.

Specification contains the material's specification(s) and has one optional attribute, authority, for namespace linking to authoritative sources of material specifications.
May occur zero or more times.

Source contains the name of the source of the material.
May occur once or not at all.

Form contains the form of the material.
May occur once or not at all.

Processing contains the processing history of the material and has one optional attribute, xmlns, for namespace linking to alternative content models for Processing.
May occur once or not at all.

Geometry contains a description of the geometry of the material and has one optional attribute, xmlns, for namespace linking to alternative content models for Geometry.
May occur once or not at all.

Characterization contains the characterization of the material, including the formula, chemical composition, phase composition, and

dimensional details. Characterization has one optional attribute, xmlns, for namespace linking to alternative content models for Characterization.
May occur once or not at all.

Properties contains the property data for the material and has one optional attribute, xmlns, for namespace linking to alternative content models for Properties.
May occur once or not at all.

Notes contains any notes pertinent to the description of the material.
May occur once or not at all.

Sample Markup for BulkDetails without xmlns Attribute

This example does not make use of the xmlns attribute for BulkDetails.

```
<BulkDetails>
      <Name>alumina</Name>
      <Class>ceramic</Class>
      <Subclass>oxide</Subclass>
      <Source>Linde Company</Source>
      <Form>bar</Form>
      <Notes>
      "Starting specimens of pure (greater than 99.9%),
      hot-pressed alumina (Linde Company, Type A-5175) were
      prepared with controlled microstructures (relative density
      greater than 98% and grain size of 1 to 2 µm. Six specimens
      (0.635 cm = 0.25 in. wide) by (0.381 cm = 0.15 in. high) by
      (4.445 cm = 1.75 in. long) were prepared by precision
      diamond machining and grinding for each grain size and each
      test temperature. ... To reduce the possible scatter in
      test data because of stress concentrations at sharp edges,
      a radius of (0.04 cm = 1/64 in.) was ground onto the edges
      of the tensile surface. The effect of this radius on
      calculations based on the conventional beam-deflection
      formulas was not significant and was well within
      experimental error. The specimens were then annealed for 24
      hours at 900°C to relieve the effects of grinding. To
      obtain uniform specimens of a particular grain size in
      sufficient number for testing, batches of 50 specimens were
      heat-treated in an air-atmosphere furnace for various
      times at 1700 °C..."
      </Notes>
</BulkDetails>
```

Notes
Markup samples for elements in the BulkDetails content model that have not been illustrated here are found elsewhere in this document.

Additional sample markup for BulkDetails appears with the sample markup for ComponentDetails.

If one wishes to ascribe the value of Name to an authority, then the markup would include the authority attribute, which would give the URI for the authoritative source of material names. The following lines of code illustrate how to do this. The URI is fictitious.

```
<Name authority="http://www.materialnames.org">
      ...
</Name>
```

Sample Markup for BulkDetails with xmlns Attribute

This sample markup makes use of the xmlns attribute for BulkDetails.

Suppose one wanted to markup the description for the bulk material using the ASTM_E1338.dtd that Dr. Halada posted to the MatML Discussion Forum on 10 April 2000. One assigns a prefix, here "ASTME1338" is used but the choice is arbitrary, that is bound to the fictitious URI "http://www.astmdtdlib/ASTM_E1338.dtd." Next, in the markup, one refers to elements from the alternative DTD using the bound prefix and the DTD's element names.

```
<BulkDetails xmlns:ASTME1338
      ='http://www.astmdtdlib.org/ASTM_E1338.dtd'>
      <ASTME1338:Material_Identification>
      <ASTME1338:Material_ID>
            <ASTME1338:Primary_Identifiers>
                  <ASTME1338:Material_Class>
                        ...
                  </ASTME1338:Material_Class>
                  <ASTME1338:Family_Name>
                        ...
                  </ASTME1338:Family_Name>
                  <ASTME1338:Family_Subclass>
                        ...
                  </ASTME1338:Family_Subclass>
                  <ASTME1338:Application_Group>
                        ...
                  </ASTME1338:Application_Group>
                  <ASTME1338:Product_Group>
                        ...
                  </ASTME1338:Product_Group>
            </ASTME1338:Primary_Identifiers>
            ...
      </ASTME1338:Material_ID>
      ...
      </ASTME1338:Material_Identification>
</BulkDetails>
```

****

```
<!ELEMENT ComponentDetails (Name,
                            Class?,
                            Subclass*,
                            Specification*,
                            Source?,
                            Form?,
                            Processing?,
                            Geometry?,
                            Characterization?,
                            Properties?,
```

```
                            Associations?,
                            Notes?)+>
<!ATTLIST ComponentDetails %xmlns;>
```

The first statement declares the content model for ComponentDetails while the second statement declares an optional attribute for ComponentDetails called xmlns. The xmlns attribute is used to link to alternative content models for ComponentDetails. The content model for ComponentDetails contains an appended + sign. This means that one or more components must be described within ComponentDetails.

ComponentDetails contains a description of the components that comprise the bulk material and is composed of the following elements.

Name contains the component's name and has one optional attribute, authority, for namespace linking to authoritative sources of component names.
Must occur once and only once.

Class contains the component's class.
May occur once or not at all.

Subclass contains the component's subclass(es).
May occur zero or more times.

Specification contains the component's specification(s) and has one optional attribute, authority, for namespace linking to authoritative sources of component specifications.
May occur zero or more times.

Source contains the name of the source of the component.
May occur once or not at all.

Form contains the form of the component.
May occur once or not at all.

Processing contains the processing history of the component and has one optional attribute, xmlns, for namespace linking to alternative content models for Processing.
May occur once or not at all.

Geometry contains a description of the geometry of the component and has one optional attribute, xmlns, for namespace linking to alternative content models for Geometry.
May occur once or not at all.

Characterization contains the characterization of the component, including the formula, chemical composition, phase composition, and dimensional details. Characterization has one optional attribute, xmlns, for namespace linking to alternative content models for Characterization.
May occur once or not at all.

Properties contains the property data for the component and has one optional attribute, xmlns, for namespace linking to alternative content models for Properties.
May occur once or not at all.

Associations contains a description of the relationships among components and has one optional attribute, xmlns, for namespace linking to alternative content models for Associations.
May occur once or not at all.

Notes contains any notes pertinent to the description of the component.
May occur once or not at all.

Sample Markup for ComponentDetails with Additional BulkDetails Sample

```
<BulkDetails>
      <Name>TiC coated AISI 1018 steel</Name>
      <Class>composite</Class>
      <Subclass>ceramic coating on metal substrate</Subclass>
      <Form>coupon</Form>
      <Properties>
            <PropertyDetails>
                  <Name>Wear (Weight Loss Analysis)</Name>
                  <Units>g</Units>
                  <DataSource>
                  A. Agarwal and N.B. Dahotre, "Pulse Electrode
                  Surfacing of Steel with TiC Coating:
                  Microstructure and Wear Properties," ASM
                  Journal of Materials Engineering and
                  Performance, Vol. 8, No. 4, pp. 479-486, 1999
                  </DataSource>
                  <MeasurementTechnique>
                        <Name>Block-on-disk tribometer</Name>
                        <Notes>
                        "Coated coupons of dimension 25 x 25mm
                        were tested for dry sliding wear
                        against a hardened steel ring rotating at
                        a linear speed of 270m/min. Weight loss
                        measurements were made after successive 2
                        min. The dry sliding wear test was
                        conducted for 10 min with an applied
                        normal load of 2 kg."
                        </Notes>
                  </MeasurementTechnique>
                  <Notes>
                  Data were digitized from Fig. 9
                  The reported unit, "gm", is interpreted to mean "g",
                  grams.
                  </Notes>
            </PropertyDetails>
            <Value type="float">.0011,.0018,.0023,.0027,.0029</Value>
            <Parameters>
                  <Name>Time</Name>
                  <Value type="integer">2,4,6,8,10</Value>
                  <Units>minutes</Units>

                  <Name>Sliding Speed (Steel Ring)</Name>
                  <Value type="integer">270,270,270,270,270</Value>
                  <Units>m/minute</Units>
                  <Notes>
                  See details in MeasurementTechnique Notes.
```

</Notes>

<Name>Applied Normal Load</Name>
<Value type="integer">2,2,2,2,2</Value>
<Units>kg</Units>
</Parameters>

<PropertyDetails>
<Name>Coefficient of Friction</Name>
<Units>none</Units>
<DataSource>
See DataSource under Wear (Weight Loss Analysis)
</DataSource>
<MeasurementTechnique>
<Name>Block-on-disk tribometer</Name>
<Notes>
"The coefficient of friction (μ) was also
recorded simultaneously by an interface
computer, which acquired data in the form
of electrical output power of the motor.
Even though data were recorded at a
frequency of 1 Hz for a total test time
of 10 min, an average of 10 successive
points was taken for computing the
coefficient of friction, μ. ...
the coefficient of friction is calculated
by measuring the changes in voltage and
current in the electrical circuit of the
motor driving the block-on-ring tribometer
during loading... "
</Notes>
</MeasurementTechnique>
</PropertyDetails>
<Value type="float">0.58</Value>
</Properties>
</BulkDetails>

<ComponentDetails>
<Name>steel</Name>
<Class>metal</Class>
<Specification authority="American Iron and Steel Institute">
AISI 1018
</Specification>
<Form>coupon</Form>
<Processing>
<Name>Mechanical polishing</Name>
<Notes>
The coupons were mechanically polished on emery
paper of grit size 240.
</Notes>

<Name>Rinsing</Name>
<Notes>
After polishing, the coupons were rinsed in acetone.
</Notes>

<Name>Coating</Name>

```
        <Notes>
        "A sintered electrode of TiC was used to deposit a
        coating on these steel coupons. The TiC electrode had
        3 to 5 wt% Ni and 1 to 3 wt% Fe as binder. Deposition
        was carried out using a handheld gun in air at room
        temperature. Pulsed electrode deposition was carried
        out at a voltage of 50V and spark time of 10µs. The
        discharge capacitance used for the PES process was
        450µF with a current of 25A."
        </Notes>
  </Processing>
  <Geometry>
        <Shape>square</Shape>
        <Dimensions>25mm x 25mm</Dimensions>
  </Geometry>
  <Properties>
        <PropertyDetails>
              <Name>Wear (Weight Loss Analysis)</Name>
              <Units>g</Units>
              <DataSource>
              See DataSource under Wear (Weight Loss Analysis)
              in BulkDetails.
              </DataSource>
              <MeasurementTechnique>
                    <Name>Block-on-disk tribometer</Name>
              </MeasurementTechnique>
              <Notes>
              See Notes under Wear (Weight Loss Analysis) in
              BulkDetails.
              </Notes>
        </PropertyDetails>
        <Value type="float">.0019,.0036,.0057,.0073,.0090</Value>
        <Parameters>
              <Name>Time</Name>
              <Value type="integer">2,4,6,8,10</Value>
              <Units>minutes</Units>

              <Name>Sliding Speed (Steel Ring)</Name>
              <Value type="integer">270,270,270,270,270</Value>
              <Units>m/minute</Units>

              <Name>Applied Normal Load</Name>
              <Value type="integer">2,2,2,2,2</Value>
              <Units>kg</Units>
        </Parameters>

        <PropertyDetails>
              <Name>Microhardness</Name>
              <Units>kg/mm^2</Units>
              <MeasurementTechnique>
                    <Name>Knoop Indentation</Name>
                    <Notes>
                    "Microhardness measurements were
                    performed on a Buehler Micromet II
                    microhardness tester using a Knoop
                    indenter with normal load of 200 g
                    applied for 15 s."
```

```xml
                        </Notes>
                  </MeasurementTechnique>
            </PropertyDetails>
            <Value type="text">172 ± 12</Value>
      </Properties>
      <Associations>
            <Associate>titanium carbide coating</Associate>
            <Relationship>substrate</Relationship>
      </Associations>

      <Name>titanium carbide coating</Name>
      <Class>carbide</Class>
      <Subclass>monocarbide</Subclass>
      <Characterization>
            <Formula>TiC·xFe</Formula>
            <PhaseComposition>
                  <Name>TiC</Name>
                  <Concentration type="text">
                  Not reported
                  </Concentration>
                  <Units>Not applicable</Units>

                  <Name>Ti</Name>
                  <Concentration type="text">
                  5 - 25
                  </Concentration>
                  <Units>wt%</Units>

                  <Name>Fe-C (austenite)</Name>
                  <Concentration type="text">
                  Not reported
                  </Concentration>
                  <Units>Not applicable</Units>

                  <Name>Fe (ferrite)</Name>
                  <Concentration type="text">
                  Not reported
                  </Concentration>
                  <Units>Not applicable</Units>

                  <Name>FeTi</Name>
                  <Concentration type="text">
                  Not reported
                  </Concentration>
                  <Units>Not applicable</Units>
                  <Qualifier>Possible</Qualifier>
            </PhaseComposition>
      </Characterization>
      <Properties>
            <PropertyDetails>
                  <Name>Microhardness</Name>
                  <Units>kg/mm^2</Units>
                  <MeasurementTechnique>
                        <Name>Knoop Indentation</Name>
                        <Notes>
                        See MeasurementTechnique Notes for
                        Microhardness in the steel component.
```

```
                        </Notes>
                  </MeasurementTechnique>
            </PropertyDetails>
            <Value type="text">1235 ± 86</Value>
      </Properties>
      <Associations>
            <Associate>AISI 1018 steel</Associate>
            <Relationship>coating</Relationship>
      </Associations>

      <Name>Heat Affected Zone (HAZ)</Name>
      <Properties>
            <PropertyDetails>
                  <Name>Microhardness</Name>
                  <Units>kg/mm^2</Units>
                  <MeasurementTechnique>
                        <Name>Knoop Indentation</Name>
                        <Notes>
                        See MeasurementTechnique Notes for
                        Microhardness in the steel component.
                        </Notes>
                  </MeasurementTechnique>
            </PropertyDetails>
            <Value type="text">352 ± 32</Value>
      </Properties>
      <Notes>Martensitic zone</Notes>
</ComponentDetails>
```

****

```
<!ENTITY % VHG SYSTEM "http://www.vhg.org.uk/dtd/vhgdtd.html">
<!ELEMENT Terms (%VHG;)>
<!ATTLIST Terms xmlns CDATA #IMPLIED>
```

Terms uses the Virtual Hyperglossary (VHG™) DTD for containing descriptions of material and property terms used in the document and has one optional attribute, xmlns, for namespace linking to alternative content models for Terms.
May occur once or not at all.

Note
While the Terms element may occur once or not at all, it encapsulates one or more termEntry elements from the VHG™ DTD. Please see the description of VHG™ at http://www.vhg.org.uk/.

Sample Markup for Terms

```
<Terms>
      <termEntry>
            <term>Elastic Modulus</term>
            <abbreviation>E</abbreviation>
            <synonym>Young's Modulus</synonym>
            <synonym>Elastic Tensile Modulus</synonym>
            <synonym>Modulus of Elasticity</synonym>
            <synonym>Coefficient of Elasticity</synonym>
            <synonym>Static Modulus</synonym>
            <synonym>Tensile Modulus</synonym>
```

```
            <synonym>Modulus in Tension</synonym>
            <definition>
            "Elastic Modulus is a measure of rigidity or
            stiffness of a material and is defined as the ratio
            of stress to strain in the elastic region. E is
            numerically equal to the slope of the stress-strain
            curve in the range of linear proportionality of
            stress to strain. Elastic Modulus is a term sometimes
            used for both compressive and tensile stresses,
            provided that the strain is directly proportional to
            the applied stress. Nonisotropic materials may
            possess greatly different compressive and tensile
            stress-strain curves, and, therefore, different bulk
            and elastic moduli."
            </definition>
            <note>
            The definition and other details provided here for
            Elastic Modulus come from "ASM Ready Reference:
            Properties & Units for Engineering Alloys",
            ISBN:0-87170-585-0.
            </note>
      </termEntry>
</Terms>
```

Note
If one wants to use an alternative to the VHG™ DTD for encoding terms, then the xmlns attribute is included with a binding prefix and a URI as illustrated in the following 3 lines of code. The URI is fictitious.

```
<Terms xmlns:AltTerms=
      "http://www.alternativeterms.org/alternativeterms.dtd">
      ...
</Terms>
```

See "Sample Markup for BulkDetails with xmlns Attribute" for full illustration of how to reference the elements of the alternative content model using the binding prefix.

****

```
<!ENTITY % SVG PUBLIC "-//W3C//DTD SVG 20001102//EN"
"http://www.w3.org/TR/2000/CR-SVG-20001102/DTD/svg-20001102.dtd">
<!ELEMENT Graphs (%SVG;)>
<!ATTLIST Graphs %xmlns;>
```

Graphs uses the Scalable Vector Graphics (SVG) DTD to describe two-dimensional graphical images and has one optional attribute, xmlns, for namespace linking to alternative content models for Graphs.
May occur once or not at all.

Note
Please see http://www.w3.org/TR/2000/CR-SVG-20001102/ for full documentation of SVG.

Sample Markup for Graphs

This sample code was generously prepared by Dr. Peter Murray-Rust. The code is markup for the phase diagram of sulfur and illustrates how 2D graphics can be included in a MatML document.

Dr. Murray-Rust marked up all lines, areas, etc. using entities so that they can be edited easily. For completeness, these entities are included and precede the sample markup.

```
...

<!ENTITY xMin "0">
<!ENTITY xMax "200">
<!ENTITY width "200">
<!ENTITY yMin "0">
<!ENTITY yMax "240">
<!ENTITY height "240">

<!ENTITY ax "&xMin;">
<!ENTITY ay "20">
<!ENTITY bx "50">
<!ENTITY by "40">
<!ENTITY cx "115">
<!ENTITY cy "60">
<!ENTITY dx "&xMax;">
<!ENTITY dy "120">
<!ENTITY ex "95.5">
<!ENTITY ey "58">
<!ENTITY fx "125">
<!ENTITY fy "200">
<!ENTITY gx "130">
<!ENTITY gy "&yMax;">

<!ENTITY % pointAttrs 'r="2" style="fill:blue;"'>
<!ENTITY pointR "3">
<!ENTITY pointStyle "fill:blue;">
<!ENTITY lineStyle "fill:none; stroke:red; stroke-width:2;">
<!ENTITY dashArray "stroke-dasharray: 5 5;">
<!ENTITY areaStyle "fill:cyan;">

<!ENTITY aCoord "&ax; &ay;">
<!ENTITY bCoord "&bx; &by;">
<!ENTITY cCoord "&cx; &cy;">
<!ENTITY dCoord "&dx; &dy;">
<!ENTITY eCoord "&ex; &ey;">
<!ENTITY fCoord "&fx; &fy;">
<!ENTITY gCoord "&gx; &gy;">

<!ENTITY abLine "C &aCoord; 30 30 &bCoord;">
<!ENTITY bcLine "C &bCoord; 90 45 &cCoord;">
<!ENTITY cdLine "C &cCoord; 170 70 &dCoord;">
<!ENTITY beLine "L &bCoord; &eCoord;">
<!ENTITY ceLine "L &cCoord; &eCoord;">
<!ENTITY cfLine "L &cCoord; &fCoord;">
<!ENTITY efLine "L &eCoord; &fCoord;">
<!ENTITY bfLine "L &bCoord; &fCoord;">
<!ENTITY fgLine "L &fCoord; &gCoord;">
...
<Graphs>
```

```
<svg>
      <g transform="matrix(2 0 0 -2 10 490)">
            <rect x="&xMin;" y="&yMin;" width="&width;"
                  height="&height;" style="fill: yellow"/>
            <!-- bounded areas -->
            <path id="bef" d="M &bCoord; &beLine; &efLine; &bfLine; z"
                  style="&areaStyle;" onmouseover="showDesc
                  ('bef.desc')">
                  <desc id="bef.desc">solid2 (solid1 metastable)</desc>
            </path>
            <path id="bec" d="M &bCoord; &bcLine; &ceLine; &beLine; z"
                  style="&areaStyle;" onmouseover="showDesc
                  ('bec.desc')">
                  <desc id="bec.desc">solid2 (gas metastable)</desc>
            </path>
            <path id="cef" d="M &cCoord; &ceLine; &efLine; &cfLine; z"
                  style="&areaStyle;" onmouseover="showDesc
                  ('cef.desc')">
                  <desc id="cef.desc">solid2 (liquid metastable)</desc>
            </path>
            <!-- unbounded areas -->
            <path id="abfg" d="M &aCoord; &abLine; &bfLine; &fgLine;
                  &gCoord; &xMin; &yMax; z" style="&areaStyle;"
                  onmouseover="showDesc('abfg.desc')">
            <desc id="abfg.desc">solid1</desc>
            </path>
            <path id="cfgd" d="M &cCoord; &cdLine; L &dx; &dy; &xMax;
                  &yMax; L &xMax; &yMax; &gx; &yMax; &fgLine; &cfLine;
                  z" style="&areaStyle;" onmouseover="showDesc
                  ('cfgd.desc')">
            <desc id="cfgd.desc">liquid</desc>
            </path>
            <path id="abcd" d="M &aCoord; &abLine; &bcLine; &cdLine;
                  L &dx; &dy; &xMax; &yMin; &xMin; &yMin; z"
                  style="&areaStyle;" onmouseover="showDesc
                  ('abcd.desc')">
                  <desc id="abcd.desc">gas</desc>
            </path>
            <!-- lines -->
            <path id="abLine" d="M &aCoord; &abLine;"
                  style="&lineStyle;" onmouseover="showDesc
                  ('ab.desc')">
                  <desc id="ab.desc">solid1-gas</desc>
            </path>
            <path id="bcLine" d="M &bCoord; &bcLine;"
                  style="&lineStyle;" onmouseover="showDesc
                  ('bc.desc')">
                  <desc id="bc.desc">solid2-gas</desc>
            </path>
            <path id="cdLine" d="M &cCoord; &cdLine;"
                  style="&lineStyle;" onmouseover="showDesc
                  ('cd.desc')">
                  <desc id="cd.desc">liquid-gas</desc>
            </path>
            <path id="beLine" d="M &bCoord; &beLine;"
                  style="&lineStyle; stroke-opacity: 0.5;"
                  onmouseover="showDesc('be.desc')">
```

```
        <desc id="be.desc">
            solid2 (solid1-gas metastable)
        </desc>
    </path>
    <path id="ceLine" d="M &cCoord; &ceLine;"
        style="&lineStyle; stroke-opacity: 0.5;"
        onmouseover="showDesc('ce.desc')">
        <desc id="ce.desc">
            solid2 (gas-liquid metastable)
        </desc>
    </path>
    <path id="efLine" d="M &eCoord; &efLine;"
        style="&lineStyle; stroke-opacity: 0.5;"
        onmouseover="showDesc('ef.desc')">
        <desc id="ef.desc">
            solid2 (solid1-liquid metastable)
        </desc>
    </path>
    <path id="bfLine" d="M &bCoord; &bfLine;"
        style="&lineStyle;" onmouseover="showDesc
        ('bf.desc')">
        <desc id="bf.desc">solid1-solid2</desc>
    </path>
    <path id="cfLine" d="M &cCoord; &cfLine;"
        style="&lineStyle;" onmouseover="showDesc
        ('cf.desc')">
        <desc id="cf.desc">solid2-liquid</desc>
    </path>
    <path id="fgLine" d="M &fCoord; &fgLine;"
        style="&lineStyle;" onmouseover="showDesc
        ('fg.desc')">
        <desc id="fg.desc">solid1-liquid</desc>
    </path>
    <!-- points -->
    <circle id="bPoint" cx="&bx;" cy="&by;" r="&pointR;"
        style="&pointStyle;" onmouseover="showDesc
        ('b.desc')">
        <desc id="b.desc">
            solid1-solid2-gas triple point
        </desc>
    </circle>
    <g transform="translate(&bx; &by;)">
        <text transform="scale(1 -1)">b</text>
    </g>
    <circle id="c" cx="&cx;" cy="&cy;" r="&pointR;"
        style="&pointStyle;" onmouseover="showDesc
        ('c.desc')">
        <desc id="c.desc">
            liquid-solid2-gas triple point
        </desc>
    </circle>
    <g transform="translate(&cx; &cy;)">
        <text transform="scale(1 -1)">c</text>
    </g>
    <circle id="ePoint" cx="&ex;" cy="&ey;" r="&pointR;"
        style="&pointStyle;" onmouseover="showDesc
        ('e.desc')">
```

```
            <desc id="e.desc">
            solid2 (metastable solid1-liquid-gas triple point)
            </desc>
        </circle>
        <g transform="translate(&ex; &ey;)">
            <text transform="scale(1 -1)">e</text>
        </g>
        <circle id="f" cx="&fx;" cy="&fy;" r="&pointR;"
            style="&pointStyle;" onmouseover="showDesc
            ('f.desc')">
            <desc id="f.desc">
                liquid-solid1-gas triple point
            </desc>
        </circle>
        <g transform="translate(&fx; &fy;)">
            <text transform="scale(1 -1)">f</text>
        </g>
    </g>
</svg>
</Graphs>
```

Note
If one wants to use an alternative to SVG for encoding graphics, then the xmlns attribute is included with a binding prefix and a URI as illustrated in the following 3 lines of code. The URI is fictitious.

```
<Graphs xmlns:2Dgraph=
    "http://www.alternativegraphics.org/2Dgraph.dtd">
    ...
</Graphs>
```

See "Sample Markup for BulkDetails with xmlns Attribute" for full illustration of how to reference the elements of the alternative content model using the binding prefix.

****

COMMENTARY AND SAMPLE MARKUP FOR THE ELEMENT DECLARATIONS USED IN THE PRINCIPLE ELEMENTS, IN ALPHEBETICAL ORDER

****

```
<!ELEMENT Associations (Associate,
                        Relationship,
                        Notes?)+>
<!ATTLIST Associations %xmlns;>
```

The first statement declares the content model for Associations while the second statement declares an optional attribute for Associations called xmlns. The xmlns attribute is used to link to alternative content models for Associations. The content model for Associations contains an appended + sign. This means that one or more Associate|Relationship|Notes tuples must occur.

> Note
> A "tuple" is a data object containing two or more data elements.

Associations is meant to describe the relationships among components in complex systems such as composites, welds, multilayer materials, etc.

and is composed of the following elements.

Associate contains the name of the component's associate. In the sample markup for Associations given earlier in ComponentDetails, for example, a TiC coating has been placed on AISI 1018 steel coupons. The Associate of the steel, then, is the "titanium carbide coating."
Must occur once and only once within the tuple.

Relationship contains the description of the relationship between the component and the Associate. In the sample markup for Associations in ComponentDetails, for example, the Associate of the "steel" component is the "titanium carbide coating." The relationship of the "steel" to the "titanium carbide coating" is that the steel is the "substrate" for the coating.
Must occur once and only once within the tuple.

Notes contains any notes pertinent to the description of the association.
May occur once or not at all within the tuple.

Sample Markup for Associations

```
<Associations>
            <Associate>titanium carbide coating</Associate>
            <Relationship>substrate</Relationship>
</Associations>
```

Note
Please see earlier in this document examples of the use of the xmlns attribute.

****

```
<!ELEMENT Characterization (Formula,
                            ChemicalComposition?,
                            PhaseComposition?,
                            DimensionalDetails?,
                            Notes?)>
<!ATTLIST Characterization %xmlns;>
```

The first statement declares the content model for Characterization while the second statement declares an optional attribute for Characterization called xmlns. The xmlns attribute is used to link to alternative content models for Characterization.

Characterization is meant to contain a description of the chemical composition of the bulk material or a component and is composed of the following elements.

Formula contains a string representation of the chemical formula for the bulk material or a component.
Must occur once and only once.

ChemicalComposition contains a detailed description of the compounds and elements that comprise the bulk material or a component and has one optional attribute, xmlns, for namespace linking to alternative content models for ChemicalComposition.

May occur once or not at all.

PhaseComposition contains the detailed description of the phases that comprise the bulk material or a component and has one optional attribute, xmlns, for namespace linking to alternative content models for PhaseComposition.
May occur once or not at all.

DimensionalDetails contains information relating to component or bulk material characteristics such as grain size, porosity, precipitate size and distribution, etc., and has one optional attribute, xmlns, for namespace linking to alternative content models for DimensionalDetails.
May occur once or not at all.

Notes contains any notes pertaining to Characterization.
May occur once or not at all.

Sample Markup for Characterization

```
<Characterization>
      <Formula>TiC·xFe</Formula>
      <ChemicalComposition>
            See Sample Markup for ChemicalComposition
      </ChemicalComposition>
      <PhaseComposition>
            See Sample Markup for PhaseComposition
      </PhaseComposition>
      <DimensionalDetails>
            See Sample Markup for DimensionalDetails
      </DimensionalDetails>
</Characterization>
```

Note
Please see earlier in this document examples of the use of the xmlns attribute.

****

```
<!ELEMENT ChemicalComposition ((Compound|Element),
                               Concentration,
                               Units,
                               Qualifier?,
                               Notes?)+>
<!ATTLIST ChemicalComposition %xmlns;>
```

The first statement declares the content model for ChemicalComposition while the second statement declares an optional attribute for ChemicalComposition called xmlns. The xmlns attribute is used to link to alternative content models for ChemicalComposition. The content model for ChemicalComposition contains an appended + sign. This means that one or more tuples of the elements comprising ChemicalComposition must occur.

ChemicalComposition contains a detailed description of the compounds and elements that comprise the bulk material or a component and is composed of the following elements.

(Compound|Element) means that one chooses to markup either a Compound or Element within the tuple. See the separate entry for Compound to learn more about its use.
Must occur once and only once within the tuple.

Concentration contains the concentration of the compound or element and has one required attribute, type, for indicating the type of value found in Concentration.
Must occur once and only once within the tuple.

Note
The type attribute of Concentration may contain "text", integer", or "float".

Units contains the concentration units and has one optional attribute, authority, for namespace linking to authoritative sources of units.
Must occur once and only once within the tuple.

Qualifier contains any qualifier pertinent to the concentration of the compound or element such as "max.", "min.", etc.
May occur once or not at all within the tuple.

Notes contains any notes pertinent to the compound or element.
May occur once or not at all within the tuple.

Sample Markup for ChemicalComposition

```
<ChemicalComposition>
      <Compound>
            <Element>Ti</Element>
            <Units>1</Units>

            <Element>C</Element>
            <Units>1</Units>
      </Compound>
      <Concentation type="text">92 - 96</Concentration>
      <Units>wt%</Units>

      <Element>Ni</Element>
      <Concentation type="text">3 - 5</Concentration>
      <Units>wt%</Units>
      <Notes>binder</Notes>

      <Element>Fe</Element>
      <Concentation type="text">1 - 3</Concentration>
      <Units>wt%</Units>
      <Notes>binder</Notes>
</ChemicalComposition>
```

Note
Please see earlier in this document examples of the use of the xmlns and authority attributes.

****

```
<!ELEMENT Compound (Element,
                    Units)+>
```

This statement declares the content model for Compound and contains an appended + sign. This means that one or more tuples of the elements comprising Compound must occur.

Compound contains the elemental description of a chemical compound and is composed of the following elements.

Element contains the symbol for a chemical element.
Must occur once and only once within the tuple.

Units contains the formula units for the chemical element.
Must occur once and only once within the tuple.

Sample Markup for Compound

```
<Compound>
      <Element>La</Element>
      <Units>1.8</Units>

      <Element>Ba</Element>
      <Units>0.15</Units>

      <Element>Ca</Element>
      <Units>1</Units>

      <Element>Cu</Element>
      <Units>2</Units>

      <Element>O</Element>
      <Units>6+y</Units>
</Compound>
```

****

```
<!ELEMENT DimensionalDetails (Name,
                              Value,
                              Units,
                              Qualifier?,
                              Notes?)+>
<!ATTLIST DimensionalDetails %xmlns;>
```

The first statement declares the content model for DimensionalDetails while the second statement declares an optional attribute for DimensionalDetails called xmlns. The xmlns attribute is used to link to alternative content models for DimensionalDetails. The content model for DimensionalDetails contains an appended + sign. This means that one or more tuples of the elements comprising DimensionalDetails must occur.

DimensionalDetails contains information relating to bulk material or component characteristics such as grain size, porosity, precipitate size and distribution, etc. and is composed of the following elements.

Name contains the name of the characteristic and has one optional attribute, authority, for namespace linking to authoritative sources of characteristic names.

Must occur once and only once within the tuple.

Value contains the value of the characteristic and has one required attribute, type, for indicating the type of value found in Value.
Must occur once and only once within the tuple.

> Note
> The type attribute of Value may contain "text", "integer", or "float".

Units contains the units for the value of the characteristic and has one optional attribute, authority, for namespace linking to authoritative sources of units.
Must occur once and only once within the tuple.

Qualifier contains any qualifier pertinent to the value of the characteristic.
May occur once or not at all within the tuple.

Notes contains any notes pertinent to the characteristic.
May occur once or not at all within the tuple.

Sample Markup for DimensionalDetails

```
<DimensionalDetails>
      <Name>grain size</Name>
      <Value type="integer">120</Value>
      <Units>µm</Units>

      <Name>porosity</Name>
      <Value type="float">34.0</Value>
      <Units>%</Units>
</DimensionalDetails>
```

Note
Please see earlier in this document examples of the use of the xmlns and authority attributes.

****

```
<!ELEMENT Geometry (Shape,
                    Dimensions?,
                    Orientation?,
                    Notes?)>
<!ATTLIST Geometry %xmlns;>
```

The first statement declares the content model for Geometry while the second statement declares an optional attribute for Geometry called xmlns. The xmlns attribute is used to link to alternative content models for Geometry.

Geometry is meant to contain a description of the geometry of the bulk material or a component and is composed of the following elements.

Shape contains a description of the shape.
Must occur once or not at all.

Dimensions contains the dimensions of the shape.
May occur once or not at all.

Orientation contains the orientation of the shape.
May occur once or not at all.

Notes contains any notes pertinent to the shape.
May occur once or not at all.

Sample Markup for Geometry

```
<Geometry>
      <Shape>square</Shape>
      <Dimensions>25mm x 25mm</Dimensions>
</Geometry>
```

Note
Please see earlier in this document examples of the use of the xmlns attribute.

****

```
<!ELEMENT MeasurementTechnique (Name,
                                Notes?)>
```

This statement declares the content model for MeasurementTechnique, which is composed of the following elements.

Name contains the name of the measurement technique and has one optional attribute, authority, for namespace linking to authoritative sources of measurement techniques and descriptions.
Must occur once and only once.

Notes contains a description of the measurement technique.
May occur once or not at all.

Sample Markup for MeasurementTechnique

```
<MeasurementTechnique>
      <Name>four-point bend</Name>
      <Notes>
      The authors cite J.B. Mitchell et al., "Microstructure
      Studies of Polycrystalline Refractory Oxides," Technical
      Report No. RAD-TR-63-32, August 7, 1963, U.S. Dept. of
      Commerce, Office of Technical Services, No. AD 413,994,
      and summarize the procedure as follows. "The elastic
      modulus and transverse bend strength of specimens of the
      various grain sizes were determined... in an air
      atmosphere. ... At least six specimens were tested at
      each combination of temperature and grain size. An
      internally-wound, Pt40Rh wire resistance furnace was
      used to obtain the test temperatures. A Pt-Pt10Rh
      thermocouple was employed to measure and control the
      temperature to within ±0.5 °C. ... A variable-speed
      motor was used to apply the load at a constant rate
      (0.91 cm/h = 10-4 in. per second). The load
      was measured with a load cell (loads accurate to
```

(±4.45 N = 1.0 lb)) and specimen deflection was
measured (accurate to (±0.06 μm = 0.00025 in.))
with a linear variable differential transformer
(LVDT) suspended from the lower knife edges on a small
alumina tube. ... The entire loading mechanism was
aligned to obtain symmetrical four-point loading of
the specimens at third points over a (3.8 cm = 1.5 in.)
span. ... Grain size determinations were made with an
optical microscope using a filar eyepiece. Grain sizes
at the limit of resolution of the optical microscope
were determined by electron microscopy. A linear intercept
technique was used."
</Notes>
</MeasurementTechnique>

Note
Please see earlier in this document examples of the use of the authority attribute.

****

```
<!ELEMENT Parameters (Name,
                      Value,
                      Units,
                      Qualifier?
                      Notes?)+>
<!ATTLIST Parameters %xmlns;>
```

The first statement declares the content model for Parameters while the second statement declares an optional attribute for Parameters called xmlns. The xmlns attribute is used to link to alternative content models for Parameters. The content model for Parameters contains an appended + sign. This means that one or more tuples of the elements comprising Parameters must occur.

Parameters contains the parameter(s) under which the property data were determined or under which the processing of the bulk material or a component occurred and is composed of the following elements.

Name contains the name of the parameter and has one optional attribute, authority, for namespace linking to authoritative sources of parameter names and descriptions.
Must occur once and only once within the tuple.

Value contains the parameter value(s) and has one required attribute, type, for indicating the type of value(s) found in Value. If multiple parameter values are entered, they must be comma delimited and synchronized with multiple entries given for the corresponding Parameters Qualifier element as well as with the Properties Value and Qualifier elements.
Must occur once and only once within the tuple.

Note
The type attribute of Value may contain "text", "integer", or "float".

Units contains the units for the parameter value(s) and has one

optional attribute, authority, for namespace linking to authoritative sources of units.
Must occur once and only once within the tuple.

Qualifier contains any quailfier pertinent to the parameter value(s) such as "max.", "min.", etc.
May occur once or not at all within the tuple.

Notes contains any Notes perinent to the description of the parameter.
May occur once or not at all within the tuple.

Sample Markup for Parameters

```
<Parameters>
      <Name>Time</Name>
      <Value type="integer">2,4,6,8,10</Value>
      <Units>minutes</Units>

      <Name>Sliding Speed (Steel Ring)</Name>
      <Value type="integer">270,270,270,270,270</Value>
      <Units>m/minute</Units>
      <Notes>See details in MeasurementTechnique Notes.</Notes>

      <Name>Applied Normal Load</Name>
      <Value type="integer">2,2,2,2,2</Value>
      <Units>kg</Units>
</Parameters>
```

Note
Please see earlier in this document examples of the use of the xmlns and authority attributes.

****

```
<!ELEMENT PhaseComposition (Name,
                            Concentration,
                            Units,
                            Qualifier?,
                            Properties?,
                            Notes?)+>
<!ATTLIST PhaseComposition %xmlns;>
```

The first statement declares the content model for PhaseComposition while the second statement declares an optional attribute for PhaseComposition called xmlns. The xmlns attribute is used to link to alternative content models for PhaseComposition. The content model for PhaseComposition contains an appended + sign. This means that one or more tuples of the elements comprising PhaseComposition must occur.

PhaseComposition contains a detailed description of the phases that comprise the bulk material or its components and is composed of the following elements.

Name contains the name of the phase and has one optional attribute, authority, for namespace linking to authoritative sources of phase names.
Must occur once and only once within the tuple.

Concentration contains the concentration of the phase and has one required attribute, type, for indicating the type of value found in Concentration.
Must occur once and only once within the tuple.

> Note
> The type attribute of Concentration may contain "text", integer", or "float".

Units contains the concentration units and has one optional attribute, authority, for namespace linking to authoritative sources of units.
Must occur once and only once within the tuple.

Qualifier contains any qualifier pertinent to the concentration of the phase such as "max.", "min.", etc.
May occur once or not at all within the tuple.

Properties contains property data for the phase and has one optional attribute, xmlns, for namespace linking to alternative content models for Properties. See the separate entry for the Properties element for sample markup.
May occur once or not at all within the tuple.

Notes contains any notes pertinent to the phase.
May occur once or not at all within the tuple.

Sample Markup for PhaseComposition

```
<PhaseComposition>
      <Name>TiC</Name>
      <Concentration type="text">Not reported</Concentration>
      <Units>Not applicable</Units>

      <Name>Ti</Name>
      <Concentration type="text">5 - 25</Concentration>
      <Units>wt%</Units>

      <Name>Fe-C (austenite)</Name>
      <Concentration type="text">Not reported</Concentration>
      <Units>Not applicable</Units>

      <Name>Fe (ferrite)</Name>
      <Concentration type="text">Not reported</Concentration>
      <Units>Not applicable</Units>

      <Name>FeTi</Name>
      <Concentration type="text">Not reported</Concentration>
      <Units>Not applicable</Units>
      <Qualifier>Indication of Possible Formation</Qualifier>
</PhaseComposition>
```

Note
Please see earlier in this document examples of the use of the xmlns and authority attributes.

****

```
<!ELEMENT Processing (Name,
                      Parameters?,
                      Result?
                      Notes?)+>
<!ATTLIST Processing %xmlns;>
```

The first statement declares the content model for Processing while the second statement declares an optional attribute for Processing called xmlns. The xmlns attribute is used to link to alternative content models for Processing. The content model for Processing contains an appended + sign. This means that one or more tuples of the elements comprising Processing must occur.

Processing contains the processing history for the bulk material or a component and is composed of the following elements.

Name contains the name of the processing step and has one optional attribute, authority, for namespace linking to authoritative sources of processing names.
Must occur once and only once within the tuple.

Parameters contains the parameter(s) under which the processing step occurred. See the separate entry for the Parameters element for sample markup.
May occur once or not at all within the tuple.

Result contains the result of the processing step.
May occur once or not at all within the tuple.

Notes contains any notes pertinent to the processing step.
May occur once or not at all within the tuple.

Sample Markup for Processing

```
<Processing>
      <Name>Mechanical polishing</Name>
      <Notes>
      The coupons were mechanically polished on emery
      paper of grit size 240.
      </Notes>

      <Name>Rinsing</Name>
      <Notes>
      After polishing, the coupons were rinsed in acetone.
      </Notes>

      <Name>Coating</Name>
      <Notes>
      "A sintered electrode of TiC was used to deposit a
      coating on these steel coupons. The TiC electrode had
      3 to 5 wt% Ni and 1 to 3 wt% Fe as binder. Deposition
      was carried out using a handheld gun in air at room
      temperature. Pulsed electrode deposition was carried
      out at a voltage of 50V and spark time of 10µs. The
      discharge capacitance used for the PES process was
      450µF with a current of 25A."
```

```
      </Notes>
</Processing>
```

Note
Please see earlier in this document examples of the use of the xmlns attribute.

****

```
<!ELEMENT Properties (PropertyDetails,
                      Value,
                      Qualifier?,
                      Parameters?)+>
<!ATTLIST Properties %xmlns;>
```

The first statement declares the content model for Properties while the second statement declares an optional attribute for Properties called xmlns. The xmlns attribute is used to link to alternative content models for Properties. The content model for Properties contains an appended + sign. This means that one or more tuples of the elements comprising Properties must occur.

Properties contains the property data for the bulk material or a component and is composed of the following elements.

PropertyDetails contains a description of the property and has one optional attribute, xmlns, for namespace linking to alternative content models for PropertyDetails.
Must occur once and only once within the tuple.

Value contains the value(s) of the property and has one required attribute, type, for indicating the type of value(s) found in Value. If multiple values are entered, they must be comma delimited and synchronized with multiple entries given for the corresponding Properties Qualifier element as well as with the Parameters Value and Qualifier elements.
Must occur once and only once within the tuple.

> Note
> The type attribute of Value may contain "text", "integer", or "float".

Qualifier contains any qualifier pertinent to the property value(s) such as "max.", "min.", etc.
May occur once or not at all within the tuple.

Parameters contains the parameter(s) under which the property data were determined and has one optional attribute, xmlns, for namespace linking to alternative content models for Parameters.
May occur once or not at all within the tuple.

Sample Markup for Properties

```
<Properties>
      <PropertyDetails>
            See Sample Markup for PropertyDetails
      </PropertyDetails>
      <Value type="integer">
```

```
            388,379,375,345,289,164,82
      </Value>
      <Qualifier>
            nominal,nominal,nominal,nominal,nominal,nominal,nominal
      </Qualifier>
      <Parameters>
            See Sample Markup for Parameters
      </Parameters>
</Properties>
```

Note
Please see earlier in this document examples of the use of the xmlns attribute.

****

```
<!ELEMENT PropertyDetails (Name,
                           Units,
                           DataSource,
                           DataType,
                           MeasurementTechnique?,
                           Notes?)>
<!ATTLIST PropertyDetails %xmlns;>
```

The first statement declares the content model for PropertyDetails while the second statement declares an optional attribute for PropertyDetails called xmlns. The xmlns attribute is used to link to alternative content models for PropertyDetails.

PropertyDetails contains a description of the property and is composed of the following elements.

Name contains the property's name and one optional attribute, authority, for namespace linking to authoritative sources of property names and descriptions.
Must occur once and only once.

Units contains the units for the property data and has one optional attribute, authority, for namespace linking to authoritative sources of units.
Must occur once and only once.

DataSource contains the name of the source of the property data and has one optional attribute, xmlns, for namespace linking to alternative content models for DataSource.
Must occur once and only once.

DataType contains a brief description of the data's type such as "test data", "design data", "bibliographic data", etc.
Must occur once and only once.

MeasurementTechnique contains the name and description of the measurement technique used to determine the property data.
May occur once or not at all.

Notes contains any notes pertinent to the description of the property.
May occur once or not at all.

Sample Markup for PropertyDetails

```
<PropertyDetails>
      <Name>Elastic Modulus</Name>
      <Units>GPa</Units>
      <DataSource>Journal</DataSource>
      <DataType>Evaluated</DataType>
      <MeasurementTechnique>
            See Sample Markup for MeasurementTechnique
      </MeasurementTechnique>
      <Notes>
      Digitized data were obtained from Figure 2 of the following
      paper.
      Title: "Mechanical Properties of Pure, Dense Aluminum Oxide
      as a Function of Temperature and Grain Size"
      Author(s): R.M. Spriggs, J.B. Mitchell, and T. Vasilos
      Publication: Journal of the American Ceramic Society
      Volume: 47 Issue: 7 Year: 1964 Page(s): 323-327
      </Notes>
</PropertyDetails>
```

Note
Please see earlier in this document examples of the use of the xmlns and authority attributes.

```
***********************************************************************
  COMMENTARY AND SAMPLE MARKUP FOR THE PARAMETER ENTITY DECLARATIONS
***********************************************************************
```

```
<!ENTITY % authority "authority CDATA #IMPLIED">
```

This statement declares what is known as a parameter entity in XML DTD's. In this case, the parameter entity authority is being defined as having the value "authority CDATA #IMPLIED". Parameter entities such as authority, which is used throughout the MatML DTD, are very useful for modularizing DTD's. Wherever one sees %authority; in the MatML DTD, "authority CDATA #IMPLIED" is substituted (without the quotation marks).

```
***********************************************************************
```

```
<!ENTITY % type "type (text | integer | float) #REQUIRED">
```

This statement declares what is known as a parameter entity in XML DTD's. In this case, the parameter entity type is being defined as having the value "type (text | integer | float) #REQUIRED". Parameter entities such as type, which is used throughout the MatML DTD, are very useful for modularizing DTD's. Wherever one sees %type; in the MatML DTD, "type (text | integer | float) #REQUIRED" is substituted (without the quotation marks).

```
***********************************************************************
```

```
<!ENTITY % xmlns "xmlns CDATA #IMPLIED">
```

This statement declares what is known as a parameter entity in XML

DTD's. In this case, the parameter entity xmlns is being defined as
having the value "xmlns CDATA #IMPLIED". Parameter entities
such as xmlns, which is used throughout the MatML DTD, are very useful
for modularizing DTD's. Wherever one sees %xmlns; in the MatML DTD,
"xmlns CDATA #IMPLIED" is substituted (without the quotation marks).

****