CLAIMS:

1. A method for producing a short-chain polyether polyol comprising the steps of:

(i) obtaining at least one oligomeric alkoxylated starter compound by reacting:

(i.a) at least one low molecular weight starter compound comprising from 3 to 9 hydroxyl groups wherein said starter compound has a hydroxy equivalent weight (HEW) of from 22 to 90 Da;

(i.b) at least one alkylene oxide in the presence of;

(i.c) a superacid catalyst present in a concentration of from 5 to 500 ppm relative to the amount of oligomeric alkoxylated starter compound to be produced; and

(i.d) at a reaction temperature of from 60°C to 180°C;

wherein the oligomeric alkoxylated starter compound has a HEW of from 60 to 200 Da;

and

(ii) converting the resulting alkoxylated starter compound into a short-chain polyether polyol without removal of the superacid catalyst by reacting:

(ii.a) said oligomeric alkoxylated starter compound with;

(ii.b) at least one alkylene oxide in the presence of;

(ii.c) at least one double-metal cyanide (DMC) catalyst, wherein the concentration of the DMC catalyst is from 10 to 10,000 ppm relative to the amount of short-chain polyether polyol to be produced; and

(ii.d) at a reaction temperature of from 90°C to 180°C;

wherein the resulting short-chain polyether polyol has a HEW of from 90 to 400 Da~~.~~; and

wherein the superacid is fluorinated sulfonic acid, a perfluoroalkylsulfonic acid, fluoroantimonic acid ($HSbF_6$), carborane superacid ($HCHB_{11}Cl_{11}$), perchloric acid ($HClO_4$), tetrafluoroboric acid (HBF_4), hexafluorophosphoric acid (HPF_6), boron trifluoride (BF_3), antimony pentafluoride (SbF_5), phosphorous pentafluoride (PF_5), or mixtures thereof;

or

wherein the superacid is trifluoromethanesulfonic (triflic) acid (CF_3SO_3H), fluorosulfonic acid (HSO_3F), fluoroantimonic acid, Magic acid (FSO_3H-SbF_5), or mixtures thereof.

2. The method of Claim 1 wherein the starter compound is trimethylolpropane, glycerol, polyglycerol, pentaerythritol, erythritol, xylitol, sorbitol, maltitol, sucrose, dextrose, invert sugar, degraded starch, degraded cellulose, hydrogenated starch hydrolysates, an aromatic Mannich polycondensate, or mixtures thereof.

~~3. The method of Claim 1 where in the superacid is fluorinated sulfonic acid, a perfluoroalkylsulfonic acid, fluoroantimonic acid ($HSbF_6$), carborane superacid ($HCHB_{11}Cl_{11}$), perchloric acid ($HClO_4$), tetrafluoroboric acid (HBF_4), hexafluorophosphoric acid (HPF_6), boron trifluoride (BF_3), antimony pentafluoride (SbF_5), phosphorous pentafluoride (PF_5), a sulfated metal oxyhydroxyide, a sulfated metal oxysilicate, a~~

~~superacid metal oxide, a supported Lewis acid, a supported Bronsted acids, a zeolites, a heterogeneous acid catalyst, a perfluorinated ion exchange polymers (PFIEP), or mixtures thereof.~~

~~4. The Method of Claim 1 wherein the superacid is trifluoromethanesulfonic (triflic) acid (CF_3SO_3H), fluorosulfonic acid (HSO_3F), fluoroantimonic acid, Magic acid (FSO_3H-SbF_5), or mixtures thereof.~~

35. The method of Claim 1 wherein the double-metal cyanide catalysis is represented by the formula:

$$M_b[M^1(CN)_r(X)_t]_c[M^2(X)_6]_d \bullet nM^3{}_xA_y$$

wherein

M and M^3 are each metals;

M^1 is a transition metal different from M,

X independently represents a group other than cyanide that coordinates with the M^1 ion; M^2 is a transition metal;

A represents an anion;

b, c and d are numbers that reflect an electrostatically neutral complex;

r is from 4 to 6;

t is from 0 to 2;

x and y are integers that balance the charges in the metal salt $M^3{}_xA_y$; and

n is zero or a positive integer.

46. The method of Claim 35 wherein:

M and M^3 independently are a metal ion selected from Zn^{+2}, Fe^{+2}, Co^{+2}, Ni^{+2}, Mo^{+4}, Mo^{+6}, Al^{+3}, V^{+4}, V^{+5}, Sr^{+2}, W^{+4}, W^{+6}, Mn^{+2}, Sn^{+2}, Sn^{+4}, Pb^{+2}, Cu^{+2}, La^{+3}, or Cr^{+3};

M^1 and M^2 are independently Fe^{+3}, Fe^{+2}, Co^{+3}, Co^{+2}, Cr^{+2}, Cr^{+3}, Mn^{+2}, Mn^{+3}, Ir^{+3}, Ni^{+2}, Rh^{+3}, Ru^{+2}, V^{+4}, V^{+5}, Ni^{2+}, Pd^{2+}, or Pt^{2+};

A is chloride, bromide, iodide, nitrate, sulfate, carbonate, cyanide, oxalate, thiocyanate, isocyanate, perchlorate, isothiocyanate, an alkanesulfonate such as methanesulfonate, an arylenesulfonate such as p-toluenesulfonate, trifluoromethanesulfonate (triflate) or a C_{1-4} carboxylate;

r is 4, 5 or 6; and

t is 0 or 1.

57. The method of Claim 1 wherein the double-metal cyanide catalyst is a zinc hexacyanocobaltate catalyst complexed with t-butanol.

~~8. A polyurethane polymer foam prepared from a formulation comprising the short-chain polyether polyol prepared by the process of Claim 1.~~

~~9. The polyurethane polymer foam of Claim 8, wherein the polyurethane polymer foam is a rigid polyurethane insulation foam.~~