in the higher aspect ratio features that may be congruent with a consumption-driven leveler depletion mechanism, as shown in FIG. **13**(*b*). Limited nickel deposition occurs on the top surfaces **1004**, **1006**, **1008**, and **1010** between the trenches **1005**, **1007**, **1009**, and **1011**, as shown in FIG. **13**(*a*)-FIG. **13**(*d*) such that the convex bumps **1012**, **1014**, **1016**, and **1018** are substantially comprised of the copper seed layer. In FIG. **13**(*e*), feature filling and planarity are obtained with modest overburden **1020**. However, significant dispersion in the feature-filling dynamics was shown in FIG. **13**(*f*).

[0085] In addition to the superconformal feature-filling mode, deposition from 10 μmol/L PEI electrolyte showed a variety of interesting pattern--density-dependent effects. For example, specimens grown at −0.9 V SCE for 3 min showed multiple examples of preferential nucleation and bottom-up growth occurring in the finest and most densely packed trench arrays with negligible deposition evident on neighboring planar or lower feature density regions. Four examples of this behavior are shown in FIGS. **14**(*a*)-**14**(*d*). These figures show distinct active and passive areas. The inhomogeneity in growth, a manifestation of self-patterning, enables selective deposition triggered by the nonuniform substrate topography. For example, FIG. **14**(*d*) shows a greater film growth proximate the center of the pattern and lesser film growth proximate each end of the pattern.

[0086] Cationic species such as protonated, nitrogen-bearing PEI were shown to substantially inhibit Ni deposition. The addition of PEI to the electrolytic bath was shown to yield bottom-up superconformal feature-filling that also included pattern scale effects whereby feature filling began preferentially in the most densely patterned (high-surface area) regions and was followed by lateral propagation of the metal nucleation and growth fonts. Patterning and designing a three dimensional recess in a dielectric substrate may provide a desired three dimensional shapes and configurations of a ferromagnetic material deposited on the dielectric substrate.

[0087] The addition of PEI to the electrolytic bath provided a deposition of the magnetic material with a smooth outer surface and little or no measurable effect on the magnetic properties.

[0088] It should be understood that the foregoing relates to exemplary aspects of the invention and that modifications may be made without departing from the spirit and scope of the invention as set forth in the following claims.

1. A process of electrodepositing at least one ferromagnetic metal into a three dimensional pattern within a substrate comprising:

providing a substrate material comprising an electrical conductive three dimensional recessed pattern in at least one surface thereof;

preparing an electrolytic bath comprising at least one ferromagnetic metal cation selected from the group consisting of Ni^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, and combinations thereof;

mixing at least one accelerating, inhibiting, or depolarizing additive into said electrolytic bath;

placing said electrical conductive pattern of said substrate into said electrolytic bath; contacting said electrical conductive pattern of said substrate with said electrolytic bath;

placing a counter electrode into said electrolytic bath;

passing an electrical current through said electrolytic bath between said electrical conductive pattern of said substrate and said counter electrode;

said electrical current being passed between said electrical conductive pattern of said substrate and said counter electrode is such that the potential between the said substrate and a reference electrode is at a value negative of −0.8V SCE, or at an applied current density in the range of 0.1 to 50 mA/cm of the area of the electrically conductive pattern of the substrate, or both; and

depositing at least a portion of said at least one ferromagnetic material into at least a portion of said three dimensional pattern wherein said at least one deposited ferromagnetic material is substantially void-free.

2. The process of claim **1** wherein said substrate is a dielectric substrate and said process further comprises:

depositing an electrical conductive material onto said three dimensional pattern of said dielectric substrate providing an electrical conductive seed layer on said substrate.

3. The process of claim **1** wherein said process step of preferentially depositing said ferromagnetic material into said three dimensional pattern results in a superconformal bottom-up deposition of said ferromagnetic material within said three dimensional pattern.

4. The process of claim **1** wherein said at least one accelerating, inhibiting, or depolarizing additive comprises a nitrogen containing compound.

5. The process of claim **1** wherein said at least one accelerating, inhibiting, or depolarizing additive has a compound selected from the group consisting of cationic surfactants, anionic surfactants, nonionic surfactants, heterocyclic benzimidazole derivatives, and combinations thereof.

6. The process of claim **1** wherein said at least one accelerating, inhibiting, or depolarizing additive comprises a compound selected from the group consisting of polyethyleneimine, 2-mercapto-5-benzimidazolesulfonic acid, and combinations thereof.

7. The process of claim **1** wherein said at least one accelerating, inhibiting, or depolarizing additive comprises polyethyleneimine.

8. The process of claim **1** wherein said at least one accelerating, inhibiting, or depolarizing additive comprises 2-mercapto-5-benzimidazolesulfonic acid.

9. The process of claim **8** wherein said 2-mercapto-5-benzimidazolesulfonic acid is in said electrolytic bath at a concentration of at least 50 μmol/L.

10. The process of claim **1** wherein said three dimensional structure has at least one trench or via with a width ranging from nanometers to macroscopic dimensions.

11. A process of electrodepositing at least one ferromagnetic material into a three dimensional pattern within a substrate comprising:

providing a substrate material having an electrical conductive portion with a three dimensional recessed pattern;

preparing an electrolytic bath comprising said at least one ferromagnetic material and at least one accelerating, inhibiting, or depolarizing additive;

said at least one ferromagnetic material comprising at least one metal cation selected from the group consisting of Ni^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, and combinations thereof;

placing said electrical conductive portion of said substrate into said electrolytic bath;

contacting said electrical conductive portion of said substrate with said electrolytic bath;

placing a counter electrode into said electrolytic bath;