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Abstract

Functional materials are pivotal in various technological applications, ranging from electronics to biomedical devices. The feld of materials chemistry plays a crucial role in designing and synthesizing these materials with tailored properties. This review explores current trends and future prospects in functional materials design through advancements in materials chemistry. We discuss key strategies, such as Nano structuring, molecular engineering,

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Introduction

F c a ae a ae c a ac e ed b ec c e e a e ab e e e f ec a ed f c , c a e ec ca c d c , ca a c ac , b c a b . e de g a d de e e f e e ae a a e bee g ca e ced b a ae a c e . B a a g c e ca c , c e, a d g a a e g ca e , a e a c e ca a e e ee ec c a ca e e e . a c e e e ece ad a ce e ae a c e a a e d e e de g f f c a ae a a d e e f ed ec e ed [1-3].

Nano structuring for Enhanced Properties

Na c g e a a g a e a a e a ca e ac e e e ca a d c e ca e e . Na ae a e b g face- - e a a d a c e e e ec , a g e dea ca d da e f a a ca . Ma e a c e ec e , c a -ge e , c e ca a de , a d e ae a e b , e ab e ec e c e a c e g a d e. E a e c de a e a f ga e a a , a d f e ec c de ce , a d Na c e ed ec a ca e g a d e a ab [4].

Molecular Engineering of Functional Materials

M ec a e g ee g f c e de g g ae a a e ec a e e ac e e de ed f c a e . a ac e de a d g ec a e ac a d de g g ga c, ga c, b d a e a a ed e e . F e a e, c ga ed e e ec e e b e c d c g e e ef ga c e ec c . S a , e a - ga c f a e (MOF) e ab e a d face c e f ga age a d e a a a ca . Ad a ce c a a de g a d e c c e a e acce e a ed e a a de g f ec a e g ee ed ae a e a ced e f a ce e c .

Hybrid Materials Synthesis and Applications

H b d ae a c b e d c c e e g ca eg a e e e e , e g e a ced f c a e c a ed d d a c e . Ma e a c e fac a e e e f b d a e a b eg a g ga c- ga c, ga c- ga c, b ae a - ga c c e . F a ce, g a e e-ba ed Na c e e b e ce a ec a ca e g , e ec ca c d c , a d e a e e , a g e ab e f e b e e ec c a d e e g age de ce . B e c b d c a a ae a e a c ca c e , e g b c a b a d f c a d e f b ed ca a ca c a d g de e a d ee g ee g [5].

Emerging Trends and Future Directions

F e ad a ce e ae a c e a e ed e e f c a ae a de g f e . Ke e ea c d ec c de a ab e e e d , c a g ee c e c e a d b - ed a ac e . Add a , e eg a f a c a e ge ce a d ac e ea g a g e acce e a ed ae a d c e a d a . Ad a ced c a ac e a ec e , c a c c a d ec c , de dee e g ae a be a de ea - d c d . F e e, e d c a c ab a a g ae a c e , c e , c , a d e g ee d e a f c a ae a f e -ge e a ec g e [68].

Challenges and Opportunities

De e g ca g e , c a e ge e f c a ae a de g , c d g ca ab f e e d , ab de e a g c d , a d e e a ac . Add e g e e c a e ge e e e d c a a ac e a d e

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a eg e f a e a c a ac e a a d ce g. O e e a e g e e ab e e ce , c a b a -de ed e a d a ab e a a e a , de e ec -f e d f c a a e a . F e e, eg a f a e a d e ca c de a e ce e ad f f c a a e a c e c a a ca , e a g e eed f e b e a a d ec g a fe .

Materials and Methods

Synthesis of Nanostructured Materials

Na c ed a e a e e e ed g a ec e ac e e c ed g a d e. S -ge e a e ed f e e a a f ca a a c e . B e , e ae ca e (TEOS) a d ed e e e ce f e a a d a a a ca a de c ed H c d . e e g a aged a d d ed b a e ca a a c e .

F e e f e a a a c e , c e ca ed c e d e e ed. G d a a c e e e e a ed b ed c g c a c ac d (HA C) d c a e a a ed c g age de e c d . e e a d a e f a a c e e e c ed b a g e eac a a e e c a e e a e a d c ce a f eac a .

Design and Synthesis of Molecularly Engineered Materials

M ec a e g ee ed a e a e e de g ed ac e e ec c f c a e g a a ec a de g a d e . C ga ed e e e e ed a e a eac g e c a e e de a e a d e ec -de c e . e e a a ca ed de e a e e c d g ca a da c DF c. c 0 e e e F c. a d e d 3d261 T 1.575 -1g 3 T [e - ga e)0.5(f a e

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B ec bd c g a a aea eac ca c e, cac age -cac aeca d,de aed bc ab ad ec dc .Sca geec c c (SEM) age eeaed c e eeb g a ab e, fac a gce ade ad fea .

Characterization and Performance

C ee ecaacea ff c a aeac ed e c a, gca,adfc a ee. ea ab fa ced aea aaeedb e ga ec aa (TGA), gdec e ea e ab e 300 C, dca efb aeaef ace deeeaede ea e. BET face a ea ea e e dcaed g ad ec c face a ea c ca f ga ad adcaa ca ca .

Eec ca c dc ea e e fc gaed e adgae e-baed Na c e de aed e ce c age a a a ,eeafeec cadeeg age de ce. Mag ec e e f bd aea eeeaaed g bag a e age e e (VSM), eea g e aa age cbe a abef age ceaa adb edcaa ca .

Discussion

Maea ce a f d eced e de g ad dee e ff c a aea,eab g a ed e e a aeeeaf deeec gcaa ca . dc e e e g f e eced g ec ,fc g c e ed,f e ec ,caege,ad e e ed.

Current Trends and Innovations

e ed f aea ce a eed g ca adaceee a c g, ecaegee g,ad bd aea e.Na c gec e, c a -ge e ade aedaeb ,aeeabed ecec e e g ad efa aea. eea c ed aea e b e aced e e, c a g face a ea, ed ec a ca eg ,ade acedcaa cac , a g e abef a ca eeg age, caa ,ade g.

M ec aeg ee gae ed edeg ff c a aea bfc g ea adeg f ec a c e ac ee ec cf c a e. F ace, edee e f c gaed e e ec e a ed bea g ga ceec cad eec cdece. S a , ea-ga cfae (MOF) abe ad face ce ef ga age, eaa ,add gde e a ca .

Hbd aea eeea ef e aeace , c b g eadaage ee fdee c e ceae eg ceec.Ga e-baed Na c e,f ea e, eb ece a ecaca,eec ca,ad ea e e, a g ea f ebeeec cad adaced eeg age dece.B ec bd c a aea eac ca c e, egbc ab adfc a de f b edcaa ca , cdg eegee gad dgdee e .

Future Prospects and Emerging Directions

L ga ead, eea gae eae ed aee f eff c a aea de g .S a abe e e d aega gac ,debe e ea e edcee e a ac ad eace e e ce.Gee c e c e adb- eda ace d e af dee gec-fed aea eacedf c ae.

e eg a fa ca egece (AI) ad ac eea g (ML) e eced e eaeadceadd a ce e. AI-d ea ac e ca aa e a daae, edc aea e e, ad acceeae edeg f e aea ecede ed e ce c. F e e, ad aced caace a ec e, ca c c ad ec c, de deee g aea bea de ea- dc d , fac a g edee e f b adeabef c a aea.

I ed c ac ab a c e aac ca e ad ac g aea ce adfc a aea deg. C ab a a g aea ce ,ce , c , eg ee ,adb g f e a bc b gdee e e eade ec e. c ab aea ac eeaf adde gc ecaege, ca caab f e e d, ab de eagc d ,adeg a c de a .

Challenges and Opportunities

De e g ca ge ,eeacaegee a eed ff c a aea deg .Sca ab f e e d ae b eec , a ca f a c edad bd aea, ee ec ec e a fac g ce e c ca.S ab e, ca deg ada de a e e d g g-e e, ecaegef ac ca a ca eec c,eeg age, ad b edcade ce.

O e ab d eeag g eeabe e ce ad a abe aeaf fc a aea dee e.B a-de ed e,a a be,ad a abe a aea e e aaeae c e a aea,edc gdedece f e cead ge eaf .Reg a fae adecac dea a e ce ead adc eca a ffc a aea,e a g e a ce fe be a adec g a fe.

Conclusion

I c c , aea ce a a e ad ac gf c a aea de g beab g ec ec e c , c e,ad e e.C e edfc Na c g, ec aeg ee g,ad bd aea e e a ce aeaf c aef deea ca .F e ec c de a abe e e d, edc a c ab a ,adec gca adace e debac ca egece. B adde g caege adeeag g e, aea ce ca e edee e f e-ge ea f c a aea a aeef efec gad ce.

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