Electronic Supplementary Material (ESI) for Journal of Materials Chemistry B.

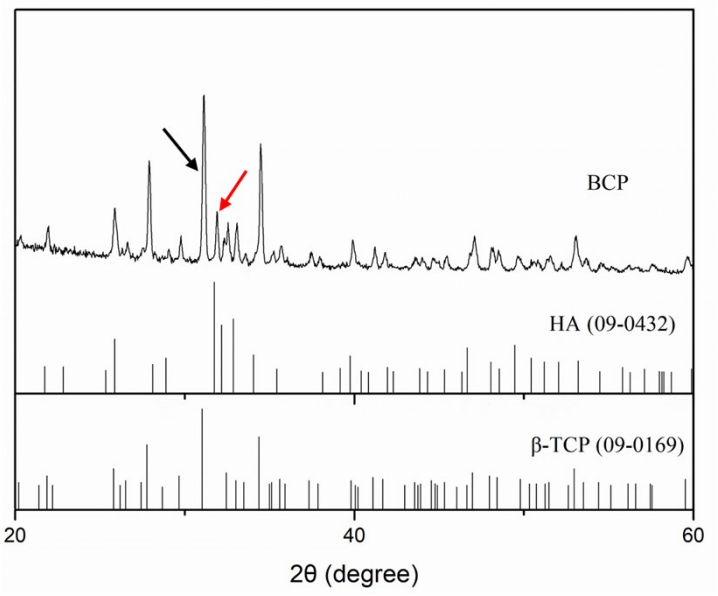

Fig. S1 XRD patterns of BCP ceramics.

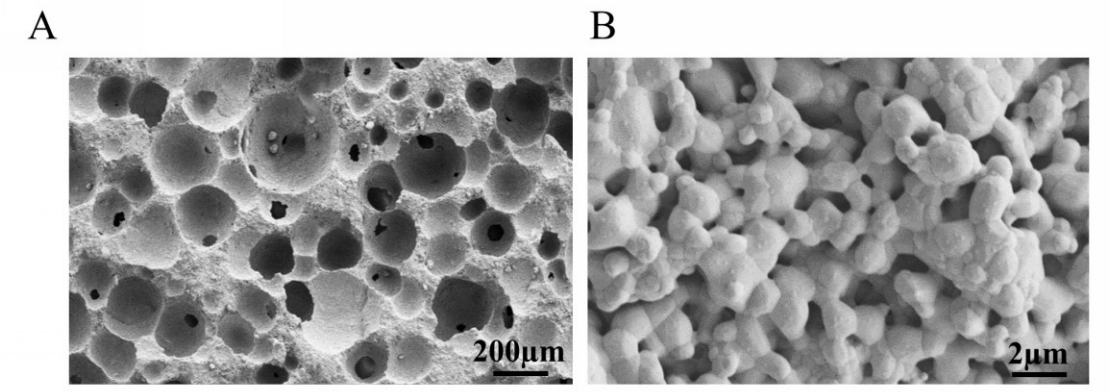

Fig. S2 SEM images of BCP ceramics.

Table S1. Inflammatory genes expressed (H value) by RAW 264.7 macrophages and the F value under different MVs parameters. *$p < 0.05$, **$p < 0.01$ represents significant difference among three levels for one factor.

Group	H value					
	D3			D5		
	Il1β	*Tnfα*	*Il10*	*Il1β*	*Tnfα*	*Il10*
1	2.8205	2.3615	2.5106	2.5022	2.4207	2.8727
2	2.1591	1.9203	2.4990	2.7083	3.8582	3.5646
3	3.2832	1.8550	3.8705	2.1546	2.8443	3.1717
4	3.1747	2.5959	2.1818	2.7658	3.2486	4.0208
5	4.4455	2.5992	3.8997	2.7730	3.1380	4.0865
6	3.0014	3.2861	2.6142	2.7964	2.3857	3.9431
7	2.6283	3.5864	2.8110	2.8503	3.6730	4.2747
8	2.8952	2.7114	2.7612	4.1786	3.9354	3.2688
9	2.5885	2.0610	2.9697	3.2624	2.9572	3.9717
Factor	F value					
A (Frequency)	6.8474**	11.4052**	0.1055	11.6070**	11.2449**	8.3506**
B (Magnitude)	0.7045	3.8471*	4.0711*	3.8981*	23.6349**	0.0812
C (Time)	5.3286*	5.9131*	9.7579**	3.7915*	5.7059*	3.6064

Table S2. Weight matrix (ω value) of inflammatory genes for RAW 264.7 cells under different MVs parameters.

Level	D3			D5			Average of weight matrix
	Il1β	*Tnfα*	*Il10*	*Il1β*	*Tnfα*	*Il10*	
A_1	0.1541	0.1744	0.0220	0.1825	0.1054	0.1698	0.1572
A_2	0.1199	0.1262	0.0215	0.1613	0.1096	0.2130	0.1460
A_3	0.1570	0.1280	0.0211	0.1306	0.0910	0.2035	0.1420
B_1	0.0522	0.0728	0.1073	0.0883	0.1563	0.0200	0.1062
B_2	0.0474	0.0860	0.1310	0.0742	0.1336	0.0196	0.1062
B_3	0.0508	0.0864	0.1353	0.0873	0.1783	0.0199	0.1218
C_1	0.1421	0.0984	0.1695	0.0834	0.0813	0.1075	0.1191
C_2	0.1564	0.1250	0.1644	0.0904	0.0706	0.1232	0.1205
C_3	0.1196	0.1023	0.2274	0.1016	0.0736	0.1229	0.1306

Table S3. Osteogenic marker expressed (H value) by BMMSCs and the F value under different CM derived from RAW 264.7 cells response to different MVs parameters. *$p < 0.05$, **$p < 0.01$ represents significant difference among three levels for one factor.

Group	H value					
	Alp protein	*Runx2*	*Col I*	*Alp*	*Opn*	*Osx*
1	28.1706	3.1544	3.8214	3.2886	2.9602	2.5611
2	40.3267	2.6181	2.8453	2.2539	1.9324	1.4393
3	31.7241	2.5614	2.7951	3.2908	3.0058	2.6566
4	37.7220	2.4423	2.8162	2.5792	3.0169	2.3189
5	42.9139	2.3912	2.7450	1.8681	2.3915	1.4386
6	53.1790	2.6206	2.8176	1.9173	2.3951	1.7608
7	32.8309	3.2623	3.2266	1.8237	2.4153	1.5108
8	22.9085	2.2797	2.9162	1.3865	2.4123	1.4294
9	22.2112	2.0457	3.8535	1.4598	2.2954	1.3603
Factor	F value					
A (Frequency)	24.7331**	1.8223	5.4794*	17.2937**	0.9906	16.2401**
B (Magnitude)	0.6592	6.9312**	3.9296*	4.70636*	3.8291*	13.4064**
C (Time)	0.4079	2.9127	1.5911	0.4719	0.5518	1.28430

Table S4. Weight matrix (ω value) of osteogenic markers for BMSCs under different CM derived from RAW 264.7 cells response to different MVs parameters.

Level	Alp protein	*Runx2*	*Col I*	*Alp*	*Opn*	*Osx*	Average of weight matrix
A_1	0.2511	0.0866	0.1960	0.2630	0.0894	0.1876	0.2244
A_2	0.3352	0.0774	0.1736	0.1895	0.0883	0.1555	0.2135
A_3	0.1953	0.0788	0.2071	0.1390	0.0806	0.1212	0.1657
B_1	0.0371	0.1707	0.0502	0.1201	0.2030	0.1593	0.1407
B_2	0.0399	0.1405	0.0433	0.0860	0.1629	0.1073	0.1080
B_3	0.0403	0.1393	0.0482	0.1041	0.1861	0.1440	0.1243
C_1	0.0337	0.1055	0.0965	0.0325	0.0644	0.0435	0.0627
C_2	0.0324	0.0931	0.0961	0.0310	0.0600	0.0387	0.0585
C_3	0.0347	0.1076	0.0885	0.0344	0.0648	0.0424	0.0621

The index layer matrix: *M*, factor layer matrix: *T*, horizontal layer matrix: *S*, and the weight value *ω* of all experimental results are listed as followed:

ELISA-Il-1β-D3

M=np.array([[0.007958223,0,0],[0.008148684,0,0],[0.007349202,0,0],[0,0.008060993,0],[0,0.007891153,0],[0,0.007481323,0],[0,0,0.007874561],[0,0,0.007587415],[0,0,0.007958223]])

T=np.array([[42.63281799,0,0],[0,42.67400765,0],[0,0,42.69818634]])

S=np.array([[0.169230769,0,0],[0,0.553846154,0],[0,0,0.276923077]])

ω=array([[0.05741686, 0. , 0.],
[0.058791 , 0. , 0.],
[0.05302291, 0. , 0.],
[0. , 0.19052024, 0.],
[0. , 0.1865061 , 0.],
[0. , 0.17681983, 0.],
[0. , 0. , 0.0931097],
[0. , 0. , 0.08971445],
[0. , 0. , 0.09409893]])

ELISA-Il-1β-D5

M=np.array([[0.007249623,0,0],[0.008461654,0,0],[0.007696559,0,0],[0,0.007958223,0],[0,0.007874561,0],[0,0.007496297,0],[0,0,0.00811338],[0,0,0.007602817],[0,0,0.007618281]])

T=np.array([[42.72073628,0,0],[0,42.86495518,0],[0,0,42.85504099]])

S=np.array([[0.552238806,0,0],[0,0.21641791,0],[0,0,0.231343284]])

ω=array([[0.17103346, 0. , 0.],
[0.19962775, 0. , 0.],
[0.18157759, 0. , 0.],
[0. , 0.0738264 , 0.],
[0. , 0.07305029, 0.],
[0. , 0.06954123, 0.],
[0. , 0. , 0.08043788],
[0. , 0. , 0.07537605],
[0. , 0. , 0.07552936]])

ELISA-Tnf-α-D3

M=np.array([[0.000286426,0,0],[0.00027771,0,0],[0.000271174,0,0],[0,0.000282271,0],[0,0.000276555,0],[0,0.000276148,0],[0,0,0.000282078],[0,0,0.000285356],[0,0,0.000268072]])

T=np.array([[3591.482753,0,0],[0,1197.641845,0],[0,0,1196.879742]])

S=np.array([[0.392061955,0,0],[0,0.156824782,0],[0,0,0.451113262]])

ω=array([[0.4033118 , 0. , 0.],
[0.39103894, 0. , 0.],
[0.3818357 , 0. , 0.],
[0. , 0.05301612, 0.],
[0. , 0.05194254, 0.],
[0. , 0.0518661 , 0.],

[0. , 0. , 0.1523019],
[0. , 0. , 0.15407179],
[0. , 0. , 0.14473967]])

ELISA-Tnf-α-D5

M=np.array([[0.00023728,0,0],[0.000236518,0,0],[0.000221363,0,0],[0,0.000231241,0],[0,0.000226194,0],[0,0.0
0023728,0],[0,0,0.000222918],[0,0,0.000234368],[0,0,0.00023769]])

T=np.array([[1438.514285,0,0],[0,1439.437655,0],[0,0,1438.896773]])

S=np.array([[0.384378844,0,0],[0,0.26199262,0],[0,0,0.353628536]])

ω=array([[0.13120029, 0. , 0.],
[0.13077895, 0. , 0.],
[0.12239923, 0. , 0.],
[0. , 0.08720608, 0.],
[0. , 0.08530274, 0.],
[0. , 0.08948352, 0.],
[0. , 0. , 0.11342847],
[0. , 0. , 0.11925463],
[0. , 0. , 0.12094498]])

PCR-*Il1β*-D3

M=np.array([[0.121022854,0,0],[0.094146373,0,0],[0.12327279,0,0],[0,0.115960254,0],[0,0.1052641,0],[0,0.112
699026,0],[0,0,0.114715686],[0,0,0.126224394],[0,0,0.096551676]])

T=np.array([[2.954715878,0,0],[0,2.994698961,0],[0,0,2.963035334]])

S=np.array([[0.431163464,0,0],[0,0.150544172,0],[0,0,0.418292364]])

ω=array([[0.15417894, 0. , 0.],
[0.11993923, 0. , 0.],
[0.15704529, 0. , 0.],
[0. , 0.05227888, 0.],
[0. , 0.04745669, 0.],
[0. , 0.05080861, 0.],
[0. , 0. , 0.14218035],
[0. , 0. , 0.15644441],
[0. , 0. , 0.1196676]])

PCR-*Tnfα*-D3

M=np.array([[0.162949006,0,0],[0.117906053,0,0],[0.119630611,0,0],[0,0.117041726,0],[0,0.138292733,0],[0,0.
138844862,0],[0,0,0.119629093],[0,0,0.152036373],[0,0,0.124366686]])

T=np.array([[2.496968244,0,0],[0,2.536916445,0],[0,0,2.525047512]])

S=np.array([[0.428762965,0,0],[0,0.245372942,0],[0,0,0.325864093]])

ω=array([[0.17445443, 0. , 0.],
[0.12623111, 0. , 0.],
[0.12807743, 0. , 0.],
[0. , 0.07285738, 0.],
[0. , 0.08608593, 0.],

[0. , 0.08642963, 0.],
[0. , 0. , 0.09843349],
[0. , 0. , 0.12509892],
[0. , 0. , 0.10233168]])

PCR-*Il10*-D3

M=np.array([[8.880279847,0,0],[8.695743644,0,0],[8.542100846,0,0],[0,7.503542571,0],[0,9.160000628,0],[0,9.454581138,0],[0,0,7.886129667],[0,0,7.650655969],[0,0,10.5813387]])

T=np.array([[0.038287589,0,0],[0,0.038287589,0],[0,0,0.038287589]])

S=np.array([[0.064786487,0,0],[0,0.373769316,0],[0,0,0.561444197]])

ω=array([[0.0220277 , 0. , 0.],
[0.02156995, 0. , 0.],
[0.02118884, 0. , 0.],
[0. , 0.10738114, 0.],
[0. , 0.13108626, 0.],
[0. , 0.13530192, 0.],
[0. , 0. , 0.16952296],
[0. , 0. , 0.16446114],
[0. , 0. , 0.2274601]])

PCR-*Il1β*-D5

M=np.array([[0.135773174,0,0],[0.119972097,0,0],[0.097167691,0,0],[0,0.123176503,0],[0,0.10352043,0],[0,0.121748956,0],[0,0,0.105515355],[0,0,0.114461091],[0,0,0.128566161]])

T=np.array([[2.833559846,0,0],[0,2.869886072,0],[0,0,2.869089687]])

S=np.array([[0.47450662,0,0],[0,0.24996083,0],[0,0,0.27553255]])

ω=array([[0.18255286, 0. , 0.],
[0.16130763, 0. , 0.],
[0.13064613, 0. , 0.],
[0. , 0.08836179, 0.],
[0. , 0.07426132, 0.],
[0. , 0.08733772, 0.],
[0. , 0. , 0.0834128],
[0. , 0. , 0.09048465],
[0. , 0. , 0.1016351]])

PCR-*Tnfα*-D5

M=np.array([[0.109609654,0,0],[0.11399371,0,0],[0.094645613,0,0],[0,0.107038251,0],[0,0.091477427,0],[0,0.122140169,0],[0,0,0.11439201],[0,0,0.099362397],[0,0,0.103569103]])

T=np.array([[3.142193917,0,0],[0,3.118608348,0],[0,0,3.151358051]])

S=np.array([[0.306028742,0,0],[0,0.468321241,0],[0,0,0.225650016]])

ω=array([[0.10540082, 0. , 0.],
[0.10961654, 0. , 0.],
[0.09101138, 0. , 0.],
[0. , 0.15633049, 0.],

[0. , 0.13360375, 0.],
[0. , 0.178387 , 0.],
[0. , 0. , 0.08134462],
[0. , 0. , 0.070657],
[0. , 0. , 0.0736484]])

PCR-*Il10*-D5

M=np.array([[9.60913429,0,0],[12.05054257,0,0],[11.51539213,0,0],[0,11.16838539,0],[0,10.91998859,0],[0,11.08669501,0],[0,0,10.08466329],[0,0,11.55729697],[0,0,11.53310872]])

T=np.array([[0.030143117,0,0],[0,0.030143117,0],[0,0,0.030143117]])

S=np.array([[0.58653314,0,0],[0,0.059675786,0],[0,0,0.3537910743]])

ω=array([[0.16988889, 0. , 0.],
[0.21305283, 0. , 0.],
[0.20359141, 0. , 0.],
[0. , 0.02008985, 0.],
[0. , 0.01964303, 0.],
[0. , 0.0199429 , 0.],
[0. , 0. , 0.10754654],
[0. , 0. , 0.12325124],
[0. , 0. , 0.12299329]])

Protein-Alp- D7

M=np.array([[100.2215871,0,0],[133.8149602,0,0],[77.95076562,0,0],[0,98.72364553,0],[0,106.1492169,0],[0,107.1144504,0],[0,0,104.2582068],[0,0,100.260021],[0,0,107.4690852]])

T=np.array([[0.003205259,0,0],[0,0.003205259,0],[0,0,0.003205259]])

S=np.array([[0.781710299,0,0],[0,0.117412927,0],[0,0,0.100876774]])

ω=array([[0.2511136 , 0. , 0.],
[0.33528462, 0. , 0.],
[0.19531219, 0. , 0.],
[0. , 0.03715354, 0.],
[0. , 0.03994807, 0.],
[0. , 0.04031133, 0.],
[0. , 0. , 0.03371045],
[0. , 0. , 0.03241769],
[0. , 0. , 0.03474864]])

PCR-*Alp*- D7

M=np.array([[8.833523968,0,0],[6.364733947,0,0],[4.670071119,0,0],[0,7.691635044,0],[0,5.508608185,0],[0,6.668085805,0],[0,0,6.592544959],[0,0,6.293029784],[0,0,6.982754292]])

T=np.array([[0.050331359,0,0],[0,0.0503313599,0],[0,0,0.050331359]])

S=np.array([[0.591718592,0,0],[0,0.310256324,0],[0,0,0.098025084]])

ω=array([[0.26308002, 0. , 0.],
[0.18955451, 0. , 0.],
[0.13908406, 0. , 0.],

[0. , 0.12010967, 0.],
[0. , 0.08602035, 0.],
[0. , 0.10412631, 0.],
[0. , 0. , 0.03252587],
[0. , 0. , 0.03104815],
[0. , 0. , 0.03445106]])

PCR-*Col-I*- D7

M=np.array([[9.461954351,0,0],[8.378901355,0,0],[9.996496329,0,0],[0,9.864361534,0],[0,8.506667502,0],[0,9.466322999,0],[0,0,9.55534728],[0,0,9.515179615],[0,0,8.76682514]])

T=np.array([[0.035922957,0,0],[0,0.035922957,0],[0,0,0.035922957]])

S=np.array([[0.576856343,0,0],[0,0.141945949,0],[0,0,0.281197707]])

ω=array([[0.19607427, 0. , 0.],
[0.17363082, 0. , 0.],
[0.20715125, 0. , 0.],
[0. , 0.05029955, 0.],
[0. , 0.0433765 , 0.],
[0. , 0.0482699 , 0.],
[0. , 0. , 0.09652289],
[0. , 0. , 0.09611714],
[0. , 0. , 0.08855767]])

PCR-*Opn*- D7

M=np.array([[7.898517036,0,0],[7.803614316,0,0],[7.123101018,0,0],[0,8.392441433,0],[0,6.736341729,0],[0,7.696449207,0],[0,0,7.767647407],[0,0,7.244823538],[0,0,7.812761424]])

T=np.array([[0.043811164,0,0],[0,0.043811164,0],[0,0,0.043811164]])

S=np.array([[0.25851909,0,0],[0,0.552133795,0],[0,0,0.189347115]])

ω=array([[0.08945878, 0. , 0.],
[0.08838391, 0. , 0.],
[0.0806764 , 0. , 0.],
[0. , 0.20301 , 0.],
[0. , 0.16294958, 0.],
[0. , 0.18617421, 0.],
[0. , 0. , 0.06443666],
[0. , 0. , 0.06009956],
[0. , 0. , 0.0648109]])

PCR-*Osx*- D7

M=np.array([[6.657140081,0,0],[5.518422778,0,0],[4.300651756,0,0],[0,6.390944469,0],[0,4.307465038,0],[0,5.777805108,0],[0,0,5.751398303],[0,0,5.118708492],[0,0,5.60610782]])

T=np.array([[0.060693553,0,0],[0,0.060693553,0],[0,0,0.060693553]])

S=np.array([[0.464547093,0,0],[0,0.410727396,0],[0,0,0.124725512]])

ω=array([[0.18769816, 0. , 0.],
[0.15559201, 0. , 0.],

[0.12125693, 0. , 0.],
[0. , 0.15931669, 0.],
[0. , 0.10737866, 0.],
[0. , 0.14403204, 0.],
[0. , 0. , 0.04353828],
[0. , 0. , 0.0387488],
[0. , 0. , 0.04243843]])

PCR-*Runx2*- D7

M=np.array([[8.334029967,0,0],[7.454264806,0,0],[7.587892539,0,0],[0,8.85911499,0],[0,7.289205235,0],[0,7.227867087,0],[0,0,8.054921214],[0,0,7.106164751],[0,0,8.215101347]])

T=np.array([[0.042778576,0,0],[0,0.042778576,0],[0,0,0.042778576]])

S=np.array([[0.243032429,0,0],[0,0.450627234,0],[0,0,0.306340336]])

ω=array([[0.08664542, 0. , 0.],
[0.07749887, 0. , 0.],
[0.07888814, 0. , 0.],
[0. , 0.17077886, 0.],
[0. , 0.1405154 , 0.],
[0. , 0.13933298, 0.],
[0. , 0. , 0.10555816],
[0. , 0. , 0.09312489],
[0. , 0. , 0.10765729]])