物理专业英语文选

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南京大学外文系公共英语教研室编

商务印书馆

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商 务 印 书 馆
1981 年 · 北京

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商　务　印　书　馆　出　版
（北京王府井大街 36 号）
新华书店北京发行所发行
安　平　印　刷　厂　印　刷

统一书号：9017·1054

1981 年 5 月第 1 版　　开本 787×1092 1/32
1985 年 3 月北京第 2 次印刷　　字数 157 千
印数 10.600 册　　印张 6 1/8

定价：0.93 元

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1. CRYSTAL AND CRYSTALLOGRAPHY

Crystal

Crystals have interested man because of their beauty and rarity since prehistoric times, but their large-scale use has been brought about mainly by the demands of solid-state physics for materials for research and devices.①

Matter may exist in three states of aggregation — solid, liquid, or gas. In the gaseous state, the molecules are separated by comparatively large distances (about 30 Å at 1 atm). This large separation results in comparatively negligible interactions between the molecules and the molecules are thus free to move in any direction. Therefore, a gas has a very low viscosity and expands to fill completely a containing vessel of any size or shape. The arrangement of molecules in a gas is essentially completely disordered. In the liquid state the molecules (or atoms) are separated by about 1 Å , and their interactions are consequently much stronger than in a gas.② Thus a liquid exhibits higher viscosity and does not expand to fill completely its container. There is short-range order in a liquid, but it does not persist more than a few atomic diameters from a given atom. In the solid state, the atomic separation is about the same as in a liquid, but the interactions between atoms are stronger. Thus the atoms are able to move only in vibrations of extremely low amplitude about fixed positions relative to one another. As a result, solids have rigidity, fixed shape, and mechanical strength. In addition, a crystalline solid is characterized by long-range order extending over many atom diameters. Upon increasing the internal en-

ergy in a crystalline solid by heating it, melting occurs at a fixed temperature for a given pressure or in a few cases sublimation to the gaseous state occurs.⑧ A further increase in internal energy will volatilize the material. At every temperature, gas or vapor of a material will exist in equilibrium with the material at a definite pressure. Thus in terms of internal energy for a particular material,④ the internal energy of the gaseous state>the internal energy of the liquid state>the internal energy of the solid state.

There is another class of materials often called amorphous solids, including glasses, waxes, and pitches, that possess such a high viscosity as to behave essentially as solids. Such materials do not have fixed melting points, and they exhibit the short-range order characteristic of liquids. It is often convenient to think of these substances as supercooled liquids.

It is interesting to point out that there is a class of materials called liquid crystals whose properties are intermediate between those of liquids and crystals.⑤ These materials exhibit the flow behavior of liquids but are not isotropic in all of their properties, as is the case with true liquids.⑥ One way of viewing liquid crystals is to consider that they have one- or at most two-dimensional order, while true crystals exhibit three-dimensional order.

Crystallography

A crystal is often described as a three-dimensional periodic array of atoms. This statement, however, is true only on the average. If we were to take an instantaneous snapshot of the crystal, we would find that the positions occupied by the atoms are far from constituting a periodic array, especially if the temperature of the crystal is high.⑦ Nevertheless, if observations

of the atomic positions are made over extended periods of time, it will be noticed that though in constant motion the atoms do move about well-defined positions (we are here ignoring the possibility of diffusion), and it is these mean positions that define the periodic lattice.⑧ The study of the architecture of this arrangement constitutes the subject of crystallography.

词　汇

crystallography [ˌkristəˈlɔgrəfi] *n.* 结晶学
interest [ˈintrist] *v.* 引人注意
beauty [ˈbju:ti] *n.* 美丽
rarity [ˈrɛəriti] *n.* 稀有；杰出，珍贵
prehistoric [ˈpri:hisˈtɔrik] *a.* 史前的
large-scale [ˈlɑ:dʒ-ˈskeil] *a.* 大规模的
solid-state [ˈsɔlid-ˈsteit] *a.* 固态的，固体的
aggregation [ˌægriˈgeiʃən] *n.* 集结
separate [ˈsepəreit] *v.* 分离
comparatively [kəmˈpærətivli] *ad.* 比较地
atm. (=atmosphere) [ˈætməsfiə] *n.* 大气压
separation [ˌsepəˈreiʃən] *n.* 分离
negligible [ˈneglidʒəbl] *a.* 可略而不计的
viscosity [visˈkɔsiti] *n.* 粘滞性
vessel [vesl] *n.* 容器
disordered [disˈɔ:dəd] *a.* 不规则的
exhibit [igˈzibit] *v.* 显示
persist [pəˈsist] *v.* 持续
vibration [vaiˈbreiʃən] *n.* 振动
rigidity [riˈdʒiditi] *n.* 刚性
crystalline [ˈkristəlain] *a.* 结晶的
characterize [ˈkæriktəraiz] *v.* 表示…特征
melt [melt] *v.* 熔化
occur [əˈkə:] *v.* 发生
sublimation [ˌsʌbliˈmeiʃən] *n.* 纯化，升华
volatilize [vɔˈlætilaiz] *v.* 挥发
equilibrium [i:kwiˈlibriəm] *n.* 平衡
class [klɑ:s] *n.* 类别
amorphous [əˈmɔ:fəs] *a.* 非晶的；无定形的
glass [glɑ:s] *n.* 玻璃
wax [wæks] *n.* 蜡
pitch [pitʃ] *n.* 沥青
possess [pəˈzes] *v.* 具有
melting point [ˈmeltiŋ ˈpɔint] *n.* 熔点
supercooled [ˈsju:pəˈku:ld] *a.* 超冷的；过冷的
intermediate [ˌintəˈmi:djət] *a.* 中间的
isotropic [ˌaisəuˈtrɔpik] *a.* 各向同性的
dimensional [diˈmenʃənəl] *a.* …维的
array [əˈrei] *n.* 排列；级数
statement [ˈsteitmənt] *n.* 陈述
instantaneous [ˌinstənˈteinjəs] *a.*

瞬时的
snapshot ['snæpʃɔt] *n.* 快照
constitute ['kɔnstitju:t] *v.* 构成
nevertheless [ˌnevəðə'les] *conj., ad.* 尽管如此；然而
mean [mi:n] *a.* 中间的
lattice ['lætis] *n.* 点阵
architecture ['a:kitektʃə] *n.* 结构
subject ['sʌbdʒikt] *n.* 科目，题材

词　组

(to) bring about 引起
relative to 与...相应(有关)，与...成比例
one another 互相
(to) point out 指出
(to) be described as 描述为
on the average 平均说来

注　释

① Crystals have interested man because of their beauty and rarity since prehistoric times, but their large-scale use has been brought about mainly by the demands of solid-state physics for materials for research and devices. 这是并列复合句，由 but 连接前后两个分句。在前一分句中，crystals have interested man 为主要成分，此外还有两个介词短语 because of their beauty and rarity 和 since prehistoric times，前者说明原因，后者说明时间；在后一分句中 has been brought about by... 为被动语态结构，意思是"由...造成的"；the demands of ... materials 意思是"固体物理对材料的要求"，demand 的后面要接 for 表示"对...的要求"；后面的介词短语 for research 修饰 materials。

② much stronger than in a gas: than 引导的是表示比较的状语从句，其中有省略，如果写完全，应该是: than the interactions (are strong) in a gas。

③ Upon increasing the internal energy in a crystalline solid by heating it, melting occurs at a fixed temperature for a given pressure or in a few cases sublimation to the gaseous state occurs. 这是一句并列复合句，其主要成分为: melting occurs or sublimation occurs, 其它均为次要成分；upon ... by heating it 为介词短语，这里的 upon 等于 on，意思是"一旦"，increasing 为动名词，作 upon 的宾语，by heating it 又是一个介词加动名词的介词短语，修饰 increasing; in a few cases 意思是"在一些情况下"，也可译为"有时"。

④ in terms of internal energy for a particular material: in terms of

的意思是"用...术语", in terms of internal energy 即"用内能这一术语表示", for a particular material 的意思是"对某一特定材料来说"。

⑤ It is interesting to point out that there is a class of materials called liquid crystals whose properties are intermediate between those of liquids and crystals. 这是主从复合句,其中的 it 为先行代词,做形式主语,代替后面的不定式 to point out...; that 引导的名词从句做 to point out 的宾语; whose properties ... crystals 为定语从句,修饰 liquid crystals; 定语从句中的 those 代替 properties, 即 the properties of liquids and crystals。

⑥ as is the case with true liquids: 这是由关系代词 as 引导的定语从句, as 在这里所代表的不是某个名词,而是代表前面整个一句话的意思; to be the case with... 的意思是"...是这一情况"。

⑦ If we were to take an instantaneous snapshot of the crystal, we would find that the positions occupied by the atoms are far from constituting a periodic array, especially if the temperature of the crystal is high. 这是主从复合句,其主要成分为: we would find..., 其它均为修饰成分; if we were... 为非真实性的条件状语从句,所以动词用过去时"were", 主句中则要用 would find; that 引导的是宾语从句; 最后一个 if 引导的状语从句只修饰宾语从句中的 are far from constituting..., 与前面无关。

⑧ Nevertheless, if observations of the atomic positions are made over extended periods of time, it will be noticed that though in constant motion the atoms do move about well-defined positions (we are here ignoring the possibility of diffusion), and it is these mean positions that define the periodic lattice. 此句包含两个以 "it" 为主语的句子,但其作用全然不同。前一个 it 为先行代词,做形式主语,代替后面的名词从句 that though in constant motion ... positions; 后一个 it 则构成强调句型,强调 these mean positions。

2. SINGLE CRYSTAL

The term single crystal is difficult to define but is usually thought of as a crystallite that has either been found in nature, separated from a polycrystalline mass, or deliberately prepared.① The crystallite should be of size sufficient for the esthetic, technological, or scientific purpose for which it is intended.② Our main concern will be with single crystals deliberately prepared and of a size greater than about 1 mm^3 because this size is a practical lower limit for convenient manipulation and for most measurements.

Such studies on how to establish that a material is crystalline involve the determination of the nature and concentration of the imperfections present in crystals.③ This field (which also includes the study of noncrystalline and polycrystalline materials) is emerging as a discipline in its own right and is called characterization.④ A material is completely characterized when the identity and position of all of its constituent atoms are known. A whole spectrum of techniques is employed to do this. However, the importance of characterization for both the grower and the user of crystals cannot be overemphasized, and the neglect of the field by the user tends more and more to make it an area where the grower should take responsibility.⑤ For instance, characterization is not the measurement of conductivity and mobility in a semiconductor, no matter how important the user may feel these parameters may be to either the device uses or the basic physics of the material.⑥ Such measurements may be essential in combination with other measurements in characterizing the

material, that is, in learning the identity and location of its constituent atoms. In any case, the identity and location of the constituent atoms determine the semiconductor and, of course, all the other properties of the material.

Single crystals find important uses in research. As we have seen, according to one classification all true solids are crystals. Thus for an understanding of the physics and chemistry of the solid state, crystals are a prerequisite. One may use a polycrystalline sample rather than a single crystal for many studies, but often a reasonably large single crystal will be required. Polycrystals contain grain boundaries. If one desires a knowledge of some bulk property of a material and he measures that property on a polycrystalline specimen he will, in many cases, measure the property of the grain boundaries and not the bulk material.⑦ A notable example of a property where single crystals are essential is the electrical conductivity of semiconductors, which is particularly impurity-sensitive. Impurities tend to segregate at grain boundaries and thus single crystals are almost always required for a determination of any conductivity-dependent property in a semiconductor. Another common effect of grain boundaries and associated voids is light scattering, and thus single crystals are often required in optical studies.

Many properties of crystals depend on the crystallographic direction in which the measurement is made, because the spatial arrangement of the constituent atoms is not in general the same in all directions. Consequently, if one determines a directionally dependent property in a polycrystalline specimen where the crystallites are randomly oriented, he will measure an average value of the property in which the directional dependence is masked.⑧

Single-crystal solids have important practical applications in technology. For example, much better frequency stability and lower acoustic losses can be achieved in single crystals than in polycrystalline aggregates. Thus single-crystal piezoelectric crystals, such as quartz, are used for frequency-control elements. Conductivity and mobility requirements dictate single-crystal semiconductors for transistors.

The existence of lasers and masers has created severe new demands for single crystals for research and applications.

词　汇

single crystal ['siŋgl 'kristl] *n.* 单晶
crystallite ['kristəlait] *n.* 微晶
polycrystalline [ˌpɔli'kristlain] *a.* 多晶的
deliberately [di'libəreitli] *ad.* 故意地，人工制造地
esthetic [i:s'θetik] *a.* 美学的，美的
intend [in'tend] *v.* 想要；打算
concern [kən'sə:n] *n.* 关系；所关切的事
manipulation [məˌnipju'leiʃən] *n.* 操作
determination [diˌtə:mi'neiʃən] *n.* 测定，确定
imperfection [ˌimpə:'fekʃən] *n.* 不完善性；缺陷
present ['preznt] *a.* 存在的
noncrystalline ['nɔn'kritlain] *a.* 非晶的
discipline ['disiplin] *n.* 纪律；学科
characterization [ˌkæriktərai'zeiʃən] *n.* 鉴定
identity [ai'dentiti] *n.* 等同性
constituent [kən'stitjuənt] *n.* 组成部分
grower ['grəuə] *n.* 培植者
user ['ju:zə] *n.* 使用者
overemphasize ['əuveremfəsaiz] *v.* 过分强调
neglect [nig'lekt] *n.* 忽视
tend [tend] *v.* 趋向；倾向；往往
responsibility [risˌpɔnsə'biliti] *n.* 责任；职责
mobility [məu'biliti] *n.* 迁移率
parameter [pə'ræmitə] *n.* 参数
classification [ˌklæsifi'keiʃən] *n.* 分类
understanding [ˌʌndə'stændiŋ] *n.* 理解
prerequisite ['pri:'rekwizit] *n.* 先决条件
reasonably ['ri:znəbli] *ad.* 合理地
boundary ['baundəri] *n.* 间界
desire [di'zaiə] *v.* 想要，愿望
bulk [bʌlk] *n.* 大块
notable ['nəutəbl] *a.* 值得注意的，显著的

impurity [im'pjuəriti] *n.* 不纯；杂质
segregate ['segrigeit] *v.* 分开；隔离
void [vɔid] *n.* 空穴
scatter ['skætə] *v.* 散射
crystallographic [ˌkristələu'græfik] *a.* 晶体学的
spatial ['speiʃəl] *a.* 空间的；立体的
directionally [di'rekʃənəli] *ad.* 定向地，有向地
randomly ['rændəmli] *ad.* 无规则地
orient ['ɔ:riənt] *v.* 定方位；定向
directional [di'rekʃənl] *a.* 有向的
mask [mɑ:sk] *v.* 掩盖
stability [stə'biliti] *n.* 稳定性
acoustic [ə'kaustik] *a.* 声学的
piezoelectric [pai'i:zəui'lektrik] *a.* 压电的
quartz [kwɔ:ts] *n.* 石英
frequency-control ['fri:kwənsi kən'trəul] *n.* 频率控制
dictate [dik'teit] *v.* 确定
mazer ['meizə] *n.* 微波激射
severe [si'viə] *a.* 严格的

词　组

(to) be thought of as 被当作为
(to) **be in its own right** 正当要求，理所当然
(to) take responsibility 负责任
no matter how 不管怎样...
according to 按照

注　释

① that has either been found in nature, separated from a polycrystalline mass, or deliberately prepared: 这是由关系代词 that 引导的定语从句，修饰 crystallite，在定语从句中 has been 后面有三个过去分词，即：has been found, has been separated, 和 has been deliberately prepared。

② The crystallite should be of size sufficient for the esthetic, technological, or scientific purpose for which it is intended: 这是主从复合句。从句首至 scientific purpose 为主句，在主句中 should be of size 意思是"大小必须为..."，should be of size sufficient for ... purpose 就是"大小必须足以适应...的目的"；for which it is intended 这一定语从句中，which 代替 purpose，即：for the purpose, it 指 crystallite，改成陈述句，应该是 the crystallite is intended for ... purpose，意思是"微晶用于...目的"，可意译为"微晶为之服务的..."。

③ Such studies on how to establish that a material is crystalline involve the determination of the nature and concentration of the

imperfections present in crystals. 这句句子的主要成分为: Such studies ... involve the determination ...; on how to ... crystals 修饰 studies, 表示在哪一方面的研究; that a material is crystalline 为名词从句,做 establish 的宾语; nature 和 concentration 均为 of 的宾语, of 表示它们和 determination 在逻辑上是动宾关系, of the imperfections 修饰 nature 和 concentration。

④ This field (which also includes the study of noncrystalline and polycrystalline materials) is emerging as a discipline in its own right and is called characterization. 这一句的主要成分为: this field is emerging ... and is called ...; as a discipline 修饰 emerging, 意思是"作为一门学科", in its own right 意思是"理所当然的"或"正当的", "独立的",修饰 discipline。

⑤ However, the importance of characterization for both the grower and the user of crystals cannot be overemphasized, and the neglect of the field by the user tends more and more to make it an area where the grower should take responsibility. 这是主从并列复合句。前一分句为简单句, 后一分句又包括一个定语从句;整个句子的主要成分是: the importance of characterization ... cannot be overemphasized, and the neglect of the field ... tends to ...; 在前一分句中, cannot be overemphasized 意思是"无论怎么强调也不过分"; 后一分句中的 tends to 是"倾向于"或"趋于"的意思; it 代替 field; where ... responsibility 为定语从句,修饰 area。

⑥ For instance, characterization is not the measurement of conductivity and mobility in a semiconductor, no matter how important the user may feel these parameters may be to either the device uses or the basic physics of the material. 这是主从复合句。no matter how 引导的是让步状语从句,从句中词序有倒装现象,正常的词序应该是: the user may feel these parameters may be important to ...; 凡是含有 no matter 引导的让步状语从句的句子,在翻译时可将从句提前,可以译为"不管...仍然..."。

⑦ If one desires a knowledge of some bulk property of a material and he measures that property on a polycrystalline specimen he will, in many cases, measure the property of the grain boundaries and not the bulk material. 这是主从复合句。从句首开始至 polycrystalline specimen 为条件状语从句,其中有两个分句, one desires ... of a material 为第一分句, he measures ... specimen 为第二分句,两个分句

用 and 连接；he will ... bulk material 为主句，其中 in many cases 的意思是“在很多情况下”。

⑧ Consequently, if one determines a directionally dependent property in a polycrystalline specimen where the crystallites are randomly oriented, he will measure an average value of the property in which the directional dependence is masked. 这是主从复合句。在 if 引导的条件状语从句中，有一个定语从句 where the crystallites ... oriented, 其中 where 为关系副词；主句是 he will measure ... is masked, 其中也包括一个定语从句 in which ... is masked, to be masked 可译为“被掩盖”。

3. SPACE LATTICES

Crystals are the outstanding examples of *orderliness* in nature. In a crystal the site of any particle is fixed precisely by the positions of its neighbours. Many geometric figures have this property. For example, the position of any corner in a regular pentagon is fixed precisely by the positions of the other corners. Each individual obeys the rule of pattern set by its neighbours. The regularity of the crystal goes beyond this, however. In a perfect crystal the pattern goes on *indefinitely* in all directions, repeating itself identically in every respect at every site, just as the pattern repeats itself periodically on a wallpaper.① Having a repeatable pattern, the crystal can grow indefinitely by simply adding more particles to continue this pattern. Only certain geometric figures can be repeated in this way. A square obviously can, but a regular pentagon cannot, as Fig. 1 shows. Each site is correctly placed in one pentagon, but the pentagons cannot be fitted together without producing non-pentagonal groups of sites between them.

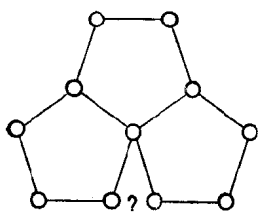

Fig. 1. A pattern which gives dissimilar sites when repeated.

What is the general condition for a pattern to be infinitely repeatable? It is that it must form a *space lattice*. To make a space lattice, we take three *basic* or *unit* vectors, *a*, *b* and *c*, as in Fig. 2, and apply each in turn to a fixed point chosen as the